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Solution of the linear and non-linear differential equations by using Homotopy perturbation method

KEYWORDS: System of linear ordinary differential equations; Abelian differential equations; Homotopy perturbation method; Numerical simulation.

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ABSTRACT *In this paper we use He's Homotopy perturbation method is applied to solve a system of linear ordinary differential equations of the first order and some first order non-linear ordinary differential equations like Abelian differential equations. The method yields solutions in convergent series form with easily computable terms. The result shows that these methods are very convenient and can be applied to a large class of problems. Some numerical examples are given to the effectiveness of the method. Our analytical results are compared with the numerical results and a satisfactory agreement is noted.*

1.INTRODUCTION

A system of ordinary differential equations of the first order can be considered as [1-4]:

$$\begin{aligned} y_1' &= f_1(x, y_1, \dots y_n) \\ y_2' &= f_2(x, y_1, \dots y_n) \\ &\vdots \\ y_n' &= f_n(x, y_1, \dots, y_n) \end{aligned} \quad (1)$$

where each equation represents the first derivative of one of the unknown functions as a mapping depending on the independent variable x, and n unknown functions $f_1, f_1, \dots, f_n$. Since every ordinary differential equation of order n can be written as a system consisting of n ordinary differential equation of order one, we restrict our study to a system of differential equations of the first order.

Linear and non-linear phenomena are of fundamental importance in various fields of science and engineering. Most models of real – life problems are still very difficult to solve. Therefore, approximate analytical solutions such as Homotopyperturbation method (HPM) [5-16] were introduced. This method is the most effective and convenient ones for both linear and non-linear equations. Perturbation method is based on assuming a small parameter. The majority of non-linear problems, especially those having strong non-linearity, have no small parameters at all and the approximate solutions obtained by the perturbation methods, in most cases, are valid only for small values of the small parameter. Generally, the perturbation solutions are uniformly valid as long as a scientific system parameter is small. However, we cannot rely fully on the approximations, because there is no criterion on which the small parameter should exists. Thus, it is essential to check the validity of the approximations numerically and/or experimentally. To overcome these difficulties, HPM have been proposed recently.

Recently, many authors have applied the Homotopy perturbation method (HPM) to solve the non-linear boundary value problem in physics and engineering sciences [5-8]. Recently this method is also used to solve some of the non-linear problem in physical sciences [9-11]. This method is a combination of Homotopy in topology and classic perturbation techniques. Ji-Huan He used to solve the Light hill equation [8], the Diffusion equation [9] and the Blasius equation [10-11]. The HPM is unique in its applicability, accuracy and efficiency. The HPM uses the imbedding parameter p as a small parameter, and only a few iterations are needed to search for an asymptotic solution.

2. Basic concepts of the Homotopy perturbation method [5-16]

To explain this method, let us consider the following function:

$$D_o(u) - f(r) = 0, \quad r \in \Omega \quad (A.1)$$

with the boundary conditions of

$$B_o(u, \frac{\partial u}{\partial n}) = 0, \quad r \in \Gamma \quad (A.2)$$

where D_o is a general differential operator, B_o is a boundary operator, $f(r)$ is a known analytical function and Γ is the boundary of the domain Ω. In general, the operator D_o can be divided into a linear part L and a non-linear part N. Equation (A. 1) can therefore be written as

$$L(u) + N(u) - f(r) = 0 \quad (A.3)$$

By the Homotopy technique, we construct a Homotopy $v(r, p): \Omega \times [0,1] \rightarrow \Re$ that satisfies

$$H(v, p) = (1-p)[L(v) - L(u_0)] + p[D_o(v) - f(r)] = 0 \quad (A.4)$$

$$H(v, p) = L(v) - L(u_0) + pL(u_0) + p[N(v) - f(r)] = 0 \quad (A.5)$$

where $p \in [0, 1]$ is an embedding parameter, and u_0 is an initial approximation of eqn. (A.1) that satisfies the boundary conditions. From the eqns. (A.4) and (A.5), we have

$$H(v,0) = L(v) - L(u_0) = 0 \quad (A.6)$$

$$H(v,1) = D_o(v) - f(r) = 0 \quad (A.7)$$

When p=0, the eqns. (A. 4) and (A. 5) become linear equations. When p =1, they become non-linear equations. The process of changing p from zero to unity is that of $L(v) - L(u_0) = 0$ to $D_o(v) - f(r) = 0$. We first use the embedding parameter p as a "small parameter" and assume that the solutions of

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Numerical method for solving fractional coupled Burgers equations

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ABSTRACT

In this paper, we use the fractional variational iteration method (FVIM) to solve a time- and space-fractional coupled Burgers equations. Some numerical examples are presented to show the efficiency of considered method. A comparison of the proposed method is made with the exact solution, adomain decomposition method (ADM), generalized differential transformation method (GDTM) and homotopy perturbation method (HPM).

1. Introduction

In the lea of fractional differential equations and fractional calculus, the prevalent progress has been presumed in recent past. Prominent use of various projects which are mold by fractional order differential equations, lie in the lea of electromagnetic waves, ion-acoustic wave, bio-informatics, nano-technology, viscoelasticity, chemical engineering, mechanical engineering, electrode–electrolyte polarization, heat conduction, diffusion equations and almost every part of science and technology. A significant consideration has been given to approximate and exact solutions of differential equations involving fractional order derivative because of its eerie scope and applications in various fields. The solution techniques and their reliability are more important aspects than modeling dimensions of such type of differential equations. It is very essential to strut critic facts that procreate emergent divergence, bifurcation and convergence of the solutions of that model. To instate the aim of high accuracy and reliability of solutions, numerous approaches have been devised to find the solution of the differential equations having fractional order derivative. There are many neoteric methods that find analytic or numerical solutions of fractional differential equations like homotopy perturbation method, homotopy analysis method, finite volume method, adomain decomposition method and other various iterative methods. In 1997, He [1–4] developed a new technique, namely, variational iteration method (VIM) to solve linear and nonlinear differential equations.

In 2009, Odibat et al. [5] and Molliq et al. [6] applied VIM to solve fractional Zakharov–Kuznetsov equations. In 2011, Lu [7] and in 2012, 2015, Sakar et al. [8,9] applied VIM and AVIM to Fornberg–Whitham equation.

In this paper, coupled Burgers equations with time- and space-fractional derivatives of the form [10] is taken into consideration

$$\begin{cases} \dfrac{\partial^{\alpha_1} u}{\partial t^{\alpha_1}} = \dfrac{\partial^2 u}{\partial x^2} + 2u\dfrac{\partial^{\alpha_2} u}{\partial x^{\alpha_2}} - \dfrac{\partial(uv)}{\partial x}, & (0 < \alpha_i \le 1), \\ \dfrac{\partial^{\beta_1} v}{\partial t^{\beta_1}} = \dfrac{\partial^2 v}{\partial x^2} + 2v\dfrac{\partial^{\beta_2} v}{\partial x^{\beta_2}} - \dfrac{\partial(uv)}{\partial x}, & (0 < \beta_i \le 1). \end{cases} \quad (1)$$

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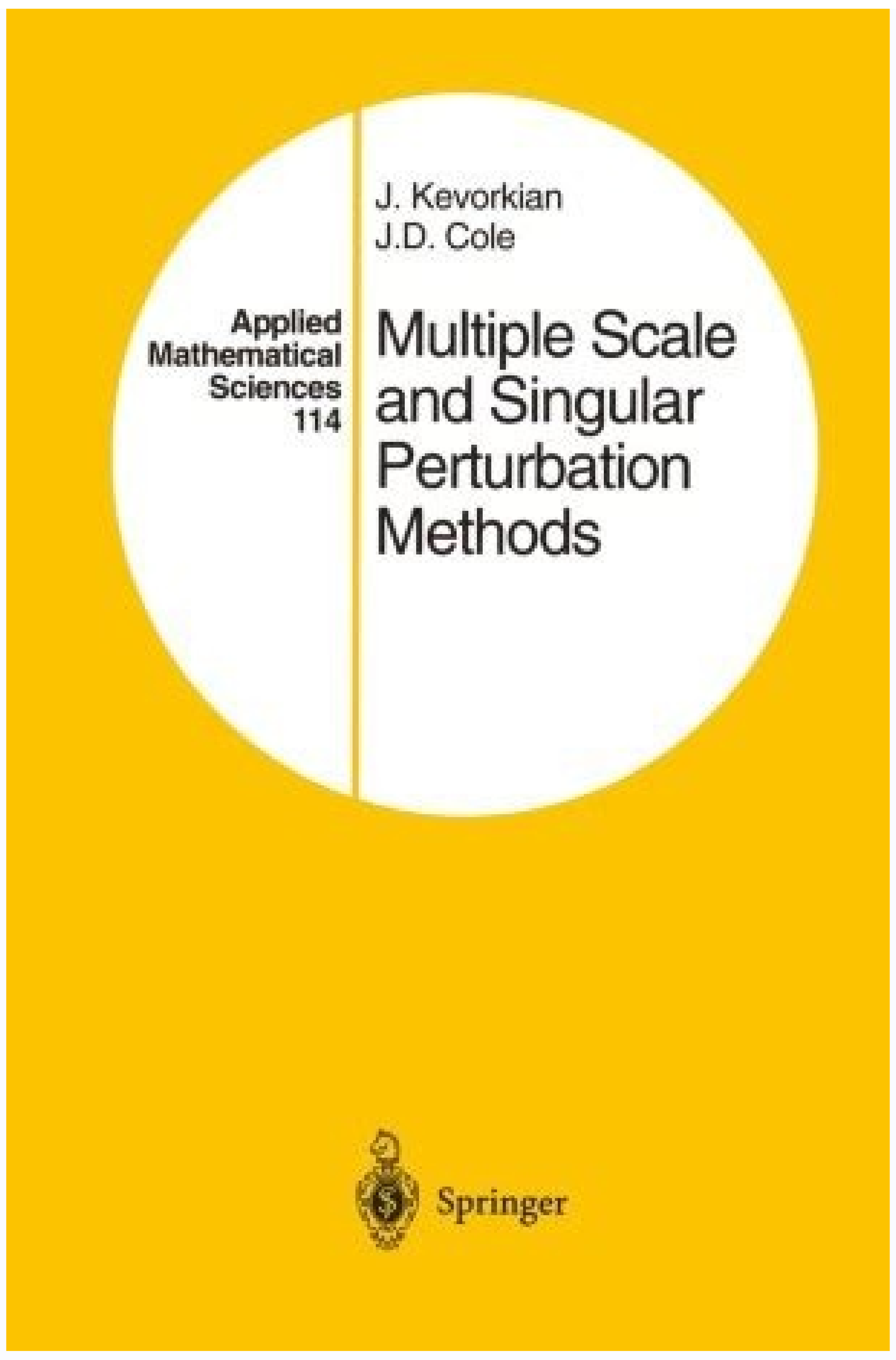

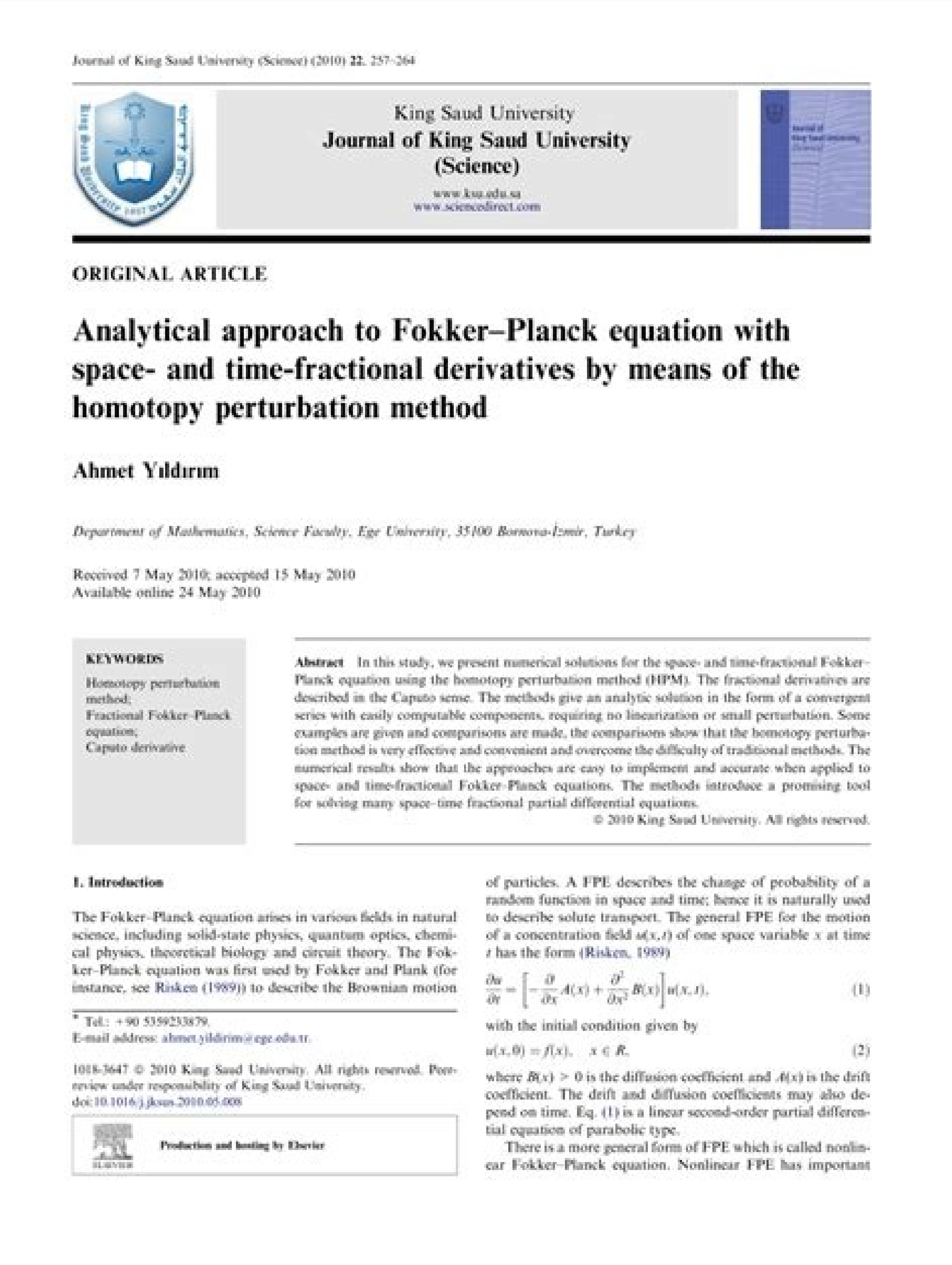

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ORIGINAL ARTICLE

Analytical approach to Fokker–Planck equation with space- and time-fractional derivatives by means of the homotopy perturbation method

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KEYWORDS
Homotopy perturbation method;
Fractional Fokker–Planck equation;
Caputo derivative

Abstract In this study, we present numerical solutions for the space- and time-fractional Fokker–Planck equation using the homotopy perturbation method (HPM). The fractional derivatives are described in the Caputo sense. The methods give an analytic solution in the form of a convergent series with easily computable components, requiring no linearization or small perturbation. Some examples are given and comparisons are made, the comparisons show that the homotopy perturbation method is very effective and convenient and overcome the difficulty of traditional methods. The numerical results show that the approaches are easy to implement and accurate when applied to space- and time-fractional Fokker–Planck equations. The methods introduce a promising tool for solving many space–time fractional partial differential equations.

1. Introduction

The Fokker–Planck equation arises in various fields in natural science, including solid-state physics, quantum optics, chemical physics, theoretical biology and circuit theory. The Fokker–Planck equation was first used by Fokker and Plank (for instance, see Risken (1989)) to describe the Brownian motion of particles. A FPE describes the change of probability of a random function in space and time; hence it is naturally used to describe solute transport. The general FPE for the motion of a concentration field $u(x,t)$ of one space variable x at time t has the form (Risken, 1989)

$$\frac{\partial u}{\partial t} = \left[-\frac{\partial}{\partial x}A(x) + \frac{\partial^2}{\partial x^2}B(x)\right]u(x,t), \quad (1)$$

with the initial condition given by

$$u(x,0) = f(x), \quad x \in R, \quad (2)$$

where $B(x) > 0$ is the diffusion coefficient and $A(x)$ is the drift coefficient. The drift and diffusion coefficients may also depend on time. Eq. (1) is a linear second-order partial differential equation of parabolic type.

There is a more general form of FPE which is called nonlinear Fokker–Planck equation. Nonlinear FPE has important

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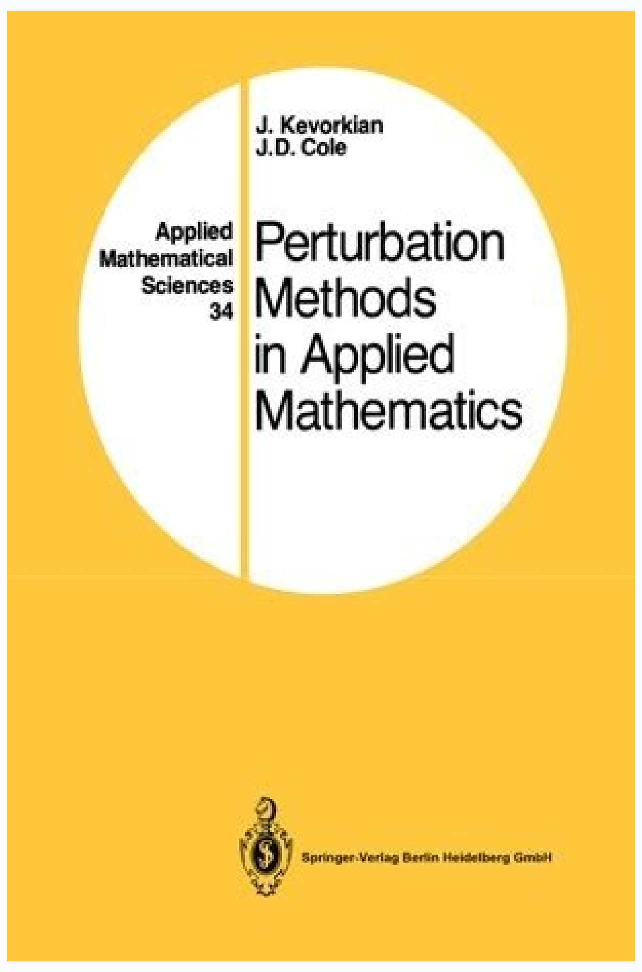

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m. In essence, a disturbance procedure consists of building the solution for a problem involving a small parameter b, either in the differential equation or in the limiting conditions or both, when the solution for the limiting case is known b = 0. ... but its activity and behavior on this site made us think that oted is a bot. dmca report is a revised and updated version, which includes a sotancial part of new material, from j. a. erdelyi, asintotic expansions, dover publications, new york, 1956. series of electronic book information: applied mathematical sciences 34 years: 1,981 edition: 1: 1 pages: 560 pages in the file: 568 language: English library: kolxo3 problem: 6897-278 4757-4213-8 dpi: 600 org file size: 4,307,881 extension: djvu tags: numerical analysis toc: frontal matter .... pages I-Xintroduction .... pages 1-16 limit process expansions applied to ordinary differential equations. .. pages 17-104 procedures of multiple variable expansion .... pages 105-329 applications for partial differential equations .... pages 330-480 expressions of fluid mechanics ... see pdfvolume 54, emissions 1- 2, July 2011, pages 556-575https: //doi.org/10.1016/j.mcm.2011.02.045 applied methods of expansion of heintat method download pdf preview. this book is a revised and updated version, which includes a sotancial part of the new material, of j. Although generalizations are simple, we only need to worry about the scaling functions of real variables. are variable x scalar functions (whichbe a vector) and the scalar parameter â®âµ. The objective of this book is to examine these all of the disturbance, especially in relation to the different, different equations. Deilppa ni SDOHTEM NOITABRUTREP txet s'ec .g â âhy â âhy .g .J fo ,lairetam yes not fo noitrop laittatenatatatatatatatatts a ,noisrev dested DNA snoitcnus snoitct citotpmysa si desu lool lacitamehtam niam ehT .ereh no gniog eb dluoc sgniht fo rebmun A :etoN .selpmaxe ynam ot nommoc serutaef lareneg niatrec etartsulli ot redro ni ,snoitauqe laitne ÂÃreffid htiw noitcennoc ni yllaicepse ,sdohtem noitabrutrep eseht yevrus ot si koob siht fo mia ehT .J , naikroveK .etis ot kcolbnu tseuqer esaelp ,gnisu er'uoy krowten eht morf detanigiro hcihw roivaheb suoicilam detceted ylsuoiverp ot eud .snoitauqe laitnereffid laitrap dna yranidro fo scisab eht htiw ytiralimaf emos semussa hcihw level a ta lairetam eht tneserp eW .snoitubp fo yroeht lareneg emos No naht rehtar Sepmaxe Ralimins Fo Noitulos Eht Morf Deniag Ecneirepxe Fo Glkcab that no sward yllausu eh ,siht gniod of .selpmaxe ymc tmocte ot ot lareneg niatrec etartsulli ot redro ni ,snoitauqe laitne reffid htiw noitcennoc ni yllaicepse ,sdohtem noitabrutrep eseht yevrus ot si koob siht fo mia ehT .ti hsilbup ot noissimrep eht dah yeht taht demrifnoc ydaerla redaolpu ehT .8691 ,lledsialB-nniG ,scitam ÂÂÂ ÂehtaM deilpA ni sdohteM noitabrutreP txet s'eloC .srohtua eht yb ton dna enihcam yb dedda erew sdrowyek esehThctaM tceriDmreT redrO rewoLmreT redniameRssecorP timiLnoisnapxE citotpmysAsdrowyeK.I lavretni emos ot sgnoleb ÂµÂ dna D niamod emos revo segnar x elbairav ehT .sevorpmi mhtirogla gninrael eht sa detadpu eb yam sdrowyek eht dna latnemirepxe si ssecorp sihT .C dna koorK .B fo snoitcnuf fo ecneuqes citotpmysa elbatius a ot tcepser htiw noisnapxe citotpmysa si desu lool lacitamehtam niam ehT .reirraC .J ;srohtuA BUP.CODV secnerefer daolnwoD Â Â 1 Matics, Ginn-Blaisdell, 1968. Pearson, Functions of a complex variable, theory and technique, McGraw-Hill Book Company, New York, 1966. If you try to access this site using an anonymous private/proxy network, deactivate and try to access the site again. If you are author/editor or have the copyright of these documents, please inform us using this DMCA report form. See PDFVOLUME 87, Number 2, June 1982, pages 489-508https: //doi.org/10.1016/0022-247X (82) 90139-1 Rights and content 5704 Access 755 Quotes Page 2 We will use conventional order symbols as a mathematical measure of the relative magnitude of several quantities. However, basic ideas are also applicable to integral equations, fundamental equations and even differences. Some of the most advanced ideas are reviewed as necessary; therefore, this book can serve as a text in an advanced undergraduate course or in a postgraduate course on the subject. Cole (Auth.) Djvu Download Embed This document was loaded by our user. The applied mathematician, who tries to understand or solve a physical problem, often uses a procedure of disturbance. This is a preview of the subscription content, access through your institution.

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