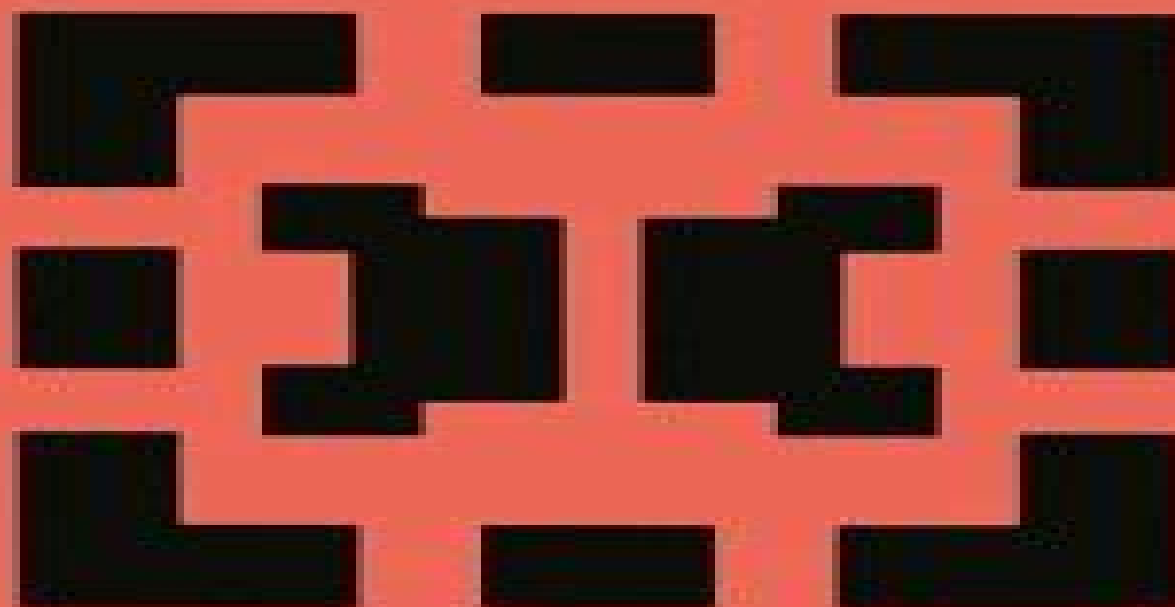


**Mathematics and Its Applications**

**A. M. Samoilenko**

**Elements of  
the Mathematical Theory  
of Multi-Frequency  
Oscillations**



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# Elements Of The Mathematical Theory Of Multi Frequency Oscillations

**Boris Sternin, Victor Shatalov**



## **Elements Of The Mathematical Theory Of Multi Frequency Oscillations:**

Elements of the Mathematical Theory of Multi-Frequency Oscillations Anatolii M Samoilenko,1991-10-31      **Elements of the Mathematical Theory of Multi-Frequency Oscillations** Anatolii M. Samoilenko,2012-12-06      *Elements of*

*Mathematical Theory of Evolutionary Equations in Banach Spaces* Anatoly M. Samoilenko,Yuriy V. Teplinsky,2013

Evolutionary equations are studied in abstract Banach spaces and in spaces of bounded number sequences For linear and nonlinear difference equations which are defined on finite dimensional and infinite dimensional tori the problem of reducibility is solved in particular in neighborhoods of their invariant sets and the basics for a theory of invariant tori and bounded semi invariant manifolds are established Also considered are the questions on existence and approximate construction of periodic solutions for difference equations in infinite dimensional spaces and the problem of extendibility of the solutions in degenerate cases For nonlinear differential equations in spaces of bounded number sequences new results are obtained in the theory of countable point boundary value problems The book contains new mathematical results that will be useful towards advances in nonlinear mechanics and theoretical physics      **Multifrequency Oscillations of Nonlinear Systems** Anatolii M. Samoilenko,R. Petryshyn,2006-04-11

In contrast to other books devoted to the averaging method and the method of integral manifolds in the present book we study oscillation systems with many varying frequencies In the process of evolution systems of this type can pass from one resonance state into another This fact considerably complicates the investigation of nonlinear oscillations In the present monograph a new approach based on exact uniform estimates of oscillation integrals is proposed On the basis of this approach numerous completely new results on the justification of the averaging method and its applications are obtained and the integral manifolds of resonance oscillation systems are studied This book is intended for a wide circle of research workers experts and engineers interested in oscillation processes as well as for students and post graduate students specialized in ordinary differential equations      **Oscillation Theory of**

**Two-Term Differential Equations** Uri Elias,2013-03-14 Oscillation theory was born with Sturm s work in 1836 It has been flourishing for the past fifty years Nowadays it is a full self contained discipline turning more towards nonlinear and functional differential equations Oscillation theory flows along two main streams The first aims to study properties which are common to all linear differential equations The other restricts its area of interest to certain families of equations and studies in maximal details phenomena which characterize only those equations Among them we find third and fourth order equations self adjoint equations etc Our work belongs to the second type and considers two term linear equations modeled after  $y^{(n)} + p(x)y = 0$  More generally we investigate  $L_n y + p(x)y = 0$  where  $L_n$  is a disconjugate operator and  $p(x)$  has a fixed sign These equations enjoy a very rich structure and are the natural generalization of the Sturm Liouville operator Results about such equations are distributed over hundreds of research papers many of them are reinvented again and again and the same phenomenon is frequently discussed from various points of view and different definitions of the authors Our aim is to introduce an order into

this plenty and arrange it in a unified and self contained way The results are readapted and presented in a unified approach In many cases completely new proofs are given and in no case is the original proof copied verbatim Many new results are included

**Asymptotic Methods for Investigating Quasiwave Equations of Hyperbolic Type** Yuri A. Mitropolsky, G. Khoma, M. Gromyak, 2012-12-06 The theory of partial differential equations is a wide and rapidly developing branch of contemporary mathematics Problems related to partial differential equations of order higher than one are so diverse that a general theory can hardly be built up There are several essentially different kinds of differential equations called elliptic hyperbolic and parabolic Regarding the construction of solutions of Cauchy mixed and boundary value problems each kind of equation exhibits entirely different properties Cauchy problems for hyperbolic equations and systems with variable coefficients have been studied in classical works of Petrovskii Leret Courant Gording Mixed problems for hyperbolic equations were considered by Vishik Ladyzhenskaya and that for general two dimensional equations were investigated by Bitsadze Vishik Gol dberg Ladyzhenskaya Myshkis and others In last decade the theory of solvability on the whole of boundary value problems for nonlinear differential equations has received intensive development Significant results for nonlinear elliptic and parabolic equations of second order were obtained in works of Gvazava Ladyzhenskaya Nakhushev Oleinik Skripnik and others Concerning the solvability in general of nonlinear hyperbolic equations which are connected to the theory of local and nonlocal boundary value problems for hyperbolic equations there are only partial results obtained by Bronshtein Pokhozhev Nakhushev

**Characteristics of Distributed-Parameter Systems** A.G. Butkovskiy, L.M. Pustyl'nikov, 2012-12-06 This book is a continuation of the book Green s Functions and Transfer Functions 35 written some ten years ago However there is no overlap whatsoever in the contents of the two books and this book can be used quite independently of the previous one This series of books represents a new kind of handbook in which are collected data on the characteristics of systems with distributed and lumped parameters The present volume covers some two hundred problems Essentially this book should be considered as a desktop handbook intended like 35 to give rapid on line access to relevant data about problems For each problem the book lists all the main characteristics of the solution standardising functions Green s functions transfer functions or matrices eigenfunctions and eigenvalues with their asymptotics roots of characteristic equations and other data In addition to systems described by a single differential equation this volume also includes degenerate multiconnected systems systems for which no Green s function or matrix exists and other special cases which are important for applications

*The Analysis of Solutions of Elliptic Equations* Nikolai Tarkhanov, 2013-03-09 This book is intended as a continuation of my book Parametrix Method in the Theory of Differential Complexes see 291 There we considered complexes of differential operators between sections of vector bundles and we strived more than for details Although there are many applications to for maximal generality overdetermined systems such an approach left me with a certain feeling of dissatisfaction especially since a large number of interesting consequences can be obtained without a great

effort The present book is conceived as an attempt to shed some light on these new applications We consider as a rule differential operators having a simple structure on open subsets of  $\mathbb{R}^n$  Currently this area is not being investigated very actively possibly because it is already very highly developed actively cf for example the book of Palamodov 213 However even in this well studied situation the general ideas from 291 allow us to obtain new results in the qualitative theory of differential equations and frequently in definitive form The greater part of the material presented is related to applications of the L rent series for a solution of a system of differential equations which is a convenient way of writing the Green formula The culminating application is an analog of the theorem of Vitushkin 303 for uniform and mean approximation by solutions of an elliptic system Somewhat afield are several questions on ill posedness but the parametrix method enables us to obtain here a series of hitherto unknown facts

### **Spline Functions and Multivariate Interpolations** Borislav D. Bojanov,H.

Hakopian,B. Sahakian,2013-06-29 Spline functions entered Approximation Theory as solutions of natural extremal problems A typical example is the problem of drawing a function curve through given  $n$   $k$  points that has a minimal norm of its  $k$  th derivative Isolated facts about the functions now called splines can be found in the papers of L Euler A Lebesgue G Birkhoff J Favard L Tschakaloff However the Theory of Spline Functions has developed in the last 30 years by the effort of dozens of mathematicians Recent fundamental results on multivariate polynomial interpolation and multivari ate splines have initiated a new wave of theoretical investigations and variety of applications The purpose of this book is to introduce the reader to the theory of spline functions The emphasis is given to some new developments such as the general Birkoff s type interpolation the extremal properties of the splines and their prominent role in the optimal recovery of functions multivariate interpolation by polynomials and splines The material presented is based on the lectures of the authors given to the students at the University of Sofia and Yerevan University during the last 10 years Some more elementary results are left as excercises and detailed hints are given

### *Existence Theory for Nonlinear Ordinary Differential Equations* Donal O'Regan,2013-04-17

We begin our applications of fixed point methods with existence of solutions to certain first order initial value problems This problem is relatively easy to treat illustrates important methods and in the end will carry us a good deal further than may first meet the eye Thus we seek solutions to  $Y' = f(t, Y)$  where  $f \in C(I \times \mathbb{R}^n, \mathbb{R}^n)$  and  $I \subset \mathbb{R}$  We shall seek solutions that are de fined either locally or globally on  $I$  according to the assumptions imposed on  $f$  Notice that 1.1 is a system of first order equations because  $f$  takes its values in  $\mathbb{R}^n$  In section 3.2 we will first establish some basic existence theorems which guarantee that a solution to 1.1 exists for  $t \geq 0$  and near zero Familiar examples show that the interval of existence can be arbi trarily short depending on the initial value  $r$  and the nonlinear behaviour of  $f$  As a result we will also examine in section 3.2 the dependence of the interval of existence on  $I$  and  $r$  We mention in passing that in the results which follow the interval  $I$  can be replaced by any bounded interval and the initial value can be specified at any point in  $I$  The reasoning needed to cover this slightly more general situation requires minor modifications on the arguments given here

### Mathematical Modelling of

Heat and Mass Transfer Processes V.G. Danilov, Victor P. Maslov, K.A. Volosov, 2012-12-06 In the present book the reader will find a review of methods for constructing a certain class of asymptotic solutions which we call self stabilizing solutions This class includes solitons kinks traveling waves etc It can be said that either the solutions from this class or their derivatives are localized in the neighborhood of a certain curve or surface For the present edition the book published in Moscow by the Nauka publishing house in 1987 was almost completely revised essentially up dated and shows our present understanding of the problems considered The new results obtained by the authors after the Russian edition was published are referred to in footnotes As before the book can be divided into two parts the methods for constructing asymptotic solutions Chapters I V and the application of these methods to some concrete problems Chapters VI VII In Appendix a method for justification some asymptotic solutions is discussed briefly The final formulas for the asymptotic solutions are given in the form of theorems These theorems are unusual in form since they present the results of calculations The authors hope that the book will be useful to specialists both in differential equations and in the mathematical modeling of physical and chemical processes The authors express their gratitude to Professor M Hazewinkel for his attention to this work and his support

**Mathematical Problems of the Dynamics of Incompressible Fluid on a Rotating Sphere** Yuri N. Skiba, 2017-09-21 This book presents selected mathematical problems involving the dynamics of a two dimensional viscous and ideal incompressible fluid on a rotating sphere In this case the fluid motion is completely governed by the barotropic vorticity equation BVE and the viscosity term in the vorticity equation is taken in its general form which contains the derivative of real degree of the spherical Laplace operator This work builds a bridge between basic concepts and concrete outcomes by pursuing a rich combination of theoretical analytical and numerical approaches and is recommended for specialists developing mathematical methods for application to problems in physics hydrodynamics meteorology and geophysics as well for upper undergraduate or graduate students in the areas of dynamics of incompressible fluid on a rotating sphere theory of functions on a sphere and flow stability

*The Cauchy Method of Residues* Dragoslav S. Mitrinovic, J.D. Keckic, 2013-12-01 Volume 1 i e the monograph *The Cauchy Method of Residues Theory and Applications* published by D Reidel Publishing Company in 1984 is the only book that covers all known applications of the calculus of residues They range from the theory of equations theory of numbers matrix analysis evaluation of real definite integrals summation of finite and infinite series expansions of functions into infinite series and products ordinary and partial differential equations mathematical and theoretical physics to the calculus of finite differences and difference equations The appearance of Volume 1 was acknowledged by the mathematical community Favourable reviews and many private communications encouraged the authors to continue their work the result being the present book Volume 2 a sequel to Volume 1 We mention that Volume 1 is a revised extended and updated translation of the book *Cauchyjev raeun ostataka sa primenama* published in Serbian by Nau na knjiga Belgrade in 1978 whereas the greater part of Volume 2 is based upon the second Serbian edition of the mentioned book from 1991 Chapter 1

is introductory while Chapters 2-6 are supplements to the corresponding chapters of Volume 1. They mainly contain results missed during the preparation of Volume 1 and also some new results published after 1982. Besides certain topics which were only briefly mentioned in Volume 1 are treated here in more detail.

**Elliptic Boundary Value Problems in the Spaces of Distributions** Y. Roitberg, 2012-12-06 This volume endeavours to summarise all available data on the theorems on isomorphisms and their ever increasing number of possible applications. It deals with the theory of solvability in generalised functions of general boundary value problems for elliptic equations. In the early sixties Lions and Magenes and Berezansky Krein and Roitberg established the theorems on complete collection of isomorphisms. Further progress of the theory was connected with proving the theorem on complete collection of isomorphisms for new classes of problems and hence with the development of new methods to prove these theorems. The theorems on isomorphisms were first established for elliptic equations with normal boundary conditions. However after the Noetherian property of elliptic problems was proved without assuming the normality of the boundary expressions this became the natural way to consider the problems of establishing the theorems on isomorphisms for general elliptic problems. The present author's method of solving this problem enabled proof of the theorem on complete collection of isomorphisms for the operators generated by elliptic boundary value problems for general systems of equations. Audience: This monograph will be of interest to mathematicians whose work involves partial differential equations, functional analysis, operator theory and the mathematics of mechanics.

**Degenerate Elliptic Equations** Serge Leventorski, 2013-11-11 This volume is the first to be devoted to the study of various properties of wide classes of degenerate elliptic operators of arbitrary order and pseudo differential operators with multiple characteristics. Conditions for operators to be Fredholm in appropriate weighted Sobolev spaces are given, a priori estimates of solutions are derived, inequalities of the Grding type are proved and the principal term of the spectral asymptotics for self adjoint operators is computed. A generalization of the classical Weyl formula is proposed. Some results are new even for operators of the second order. In addition an analogue of the Boutet de Monvel calculus is developed and the index is computed. For postgraduate and research mathematicians, physicists and engineers whose work involves the solution of partial differential equations.

**Combinatorics Advances** Charles J. Colbourn, Ebdollah Sayed Mahmoodian, 2013-12-01 On March 28-31, 1994 Farvardin 8-11, 1373 by Iranian calendar the Twenty fifth Annual Iranian Mathematics Conference AIMC25 was held at Sharif University of Technology in Tehran Islamic Republic of Iran. Its sponsors included the Iranian Mathematical Society and the Department of Mathematical Sciences at Sharif University of Technology. Among the keynote speakers were Professor Dr Andreas Dress and Professor Richard K Guy. Their plenary lectures on combinatorial themes were complemented by invited and contributed lectures in a Combinatorics Session. This book is a collection of refereed papers submitted primarily by the participants after the conference. The topics covered are diverse spanning a wide range of combinatorics and allied areas in discrete mathematics. Perhaps the strength and variety of the papers here serve as the best indications that combinatorics is

advancing quickly and that the Iranian mathematics community contains very active contributors We hope that you find the papers mathematically stimulating and look forward to a long and productive growth of combinatorial mathematics in Iran

**Differential Equations on Complex Manifolds** Boris Sternin, Victor Shatalov, 2013-03-09 The present monograph is devoted to the complex theory of differential equations Not yet a handbook neither a simple collection of articles the book is a first attempt to present a more or less detailed exposition of a young but promising branch of mathematics that is the complex theory of partial differential equations Let us try to describe the framework of this theory First simple examples show that solutions of differential equations are as a rule ramifying analytic functions and hence are not regular near points of their ramification Second bearing in mind these important properties of solutions we shall try to describe the method solving our problem Surely one has first to consider differential equations with constant coefficients The apparatus solving such problems is well known in the real theory of differential equations this is the Fourier transformation Unfortunately such a transformation had not yet been constructed for complex analytic functions and the authors had to construct by themselves This transformation is of course the key notion of the whole theory

**Basic Topological Structures of Ordinary Differential Equations** V.V. Filippov, 2013-03-09 The aim of this book is a detailed study of topological effects related to continuity of the dependence of solutions on initial values and parameters This allows us to develop cheaply a theory which deals easily with equations having singularities and with equations with multivalued right hand sides differential inclusions An explicit description of corresponding topological structures expands the theory in the case of equations with continuous right hand sides also In reality this is a new science where Ordinary Differential Equations General Topology Integration theory and Functional Analysis meet In what concerns equations with discontinuities and differential inclusions we do not restrict the consideration to the Cauchy problem but we show how to develop an advanced theory whose volume is commensurable with the volume of the existing theory of Ordinary Differential Equations The level of the account rises in the book step by step from second year student to working scientist

*Banach Space Complexes* C.-G. Ambrozie, Florian-Horia Vasilescu, 2012-12-06 The aim of this work is to initiate a systematic study of those properties of Banach space complexes that are stable under certain perturbations A Banach space complex is essentially an object of the form  $\bigoplus_{p \in I} X_p$  where  $p$  runs a finite or infinite interval of integers  $X_p$  are Banach spaces and  $\bigoplus_{p \in I} X_p \rightarrow \bigoplus_{p \in I} X_{p+1}$  are continuous linear operators such that  $\bigoplus_{p \in I} O_p = 0$  for all indices  $p$  In particular every continuous linear operator  $S: X \rightarrow Y$  where  $X, Y$  are Banach spaces may be regarded as a complex  $0 \rightarrow X \xrightarrow{S} Y \rightarrow 0$  The already existing Fredholm theory for linear operators suggested the possibility to extend its concepts and methods to the study of Banach space complexes The basic stability properties valid for semi Fredholm operators have their counterparts in the more general context of Banach space complexes We have in mind especially the stability of the index i.e the extended Euler characteristic under small or compact perturbations but other related stability results can also be successfully extended Banach or Hilbert space complexes have penetrated the functional analysis from at



least two apparently disjoint directions A first direction is related to the multivariable spectral theory in the sense of J L

**Attractor Dimension Estimates for Dynamical Systems: Theory and Computation** Nikolay Kuznetsov, Volker Reitmann, 2020-07-02 This book provides analytical and numerical methods for the estimation of dimension characteristics Hausdorff Fractal Carathéodory dimensions for attractors and invariant sets of dynamical systems and cocycles generated by smooth differential equations or maps in finite dimensional Euclidean spaces or on manifolds It also discusses stability investigations using estimates based on Lyapunov functions and adapted metrics Moreover it introduces various types of Lyapunov dimensions of dynamical systems with respect to an invariant set based on local global and uniform Lyapunov exponents and derives analytical formulas for the Lyapunov dimension of the attractors of the Hénon and Lorenz systems Lastly the book presents estimates of the topological entropy for general dynamical systems in metric spaces and estimates of the topological dimension for orbit closures of almost periodic solutions to differential equations

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