

dynamics of linear operators cambridge tracts in mathematics

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Explore the intricate world of linear operators and their dynamic behavior, a fundamental topic within pure mathematics. This specialized text delves into the evolution and properties of these essential mathematical structures over time, offering deep insights crucial for advanced study in functional analysis and mathematical dynamics. It's an indispensable resource for researchers and students seeking to understand the underlying principles governing linear operator systems.

Course materials cover topics from beginner to advanced levels.

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Dynamics of Linear Operators

The first book to assemble the wide body of theory which has rapidly developed on the dynamics of linear operators. Written for researchers in operator theory, but also accessible to anyone with a reasonable background in functional analysis at the graduate level.

DYNAMICS OF LINEAR OPERATORS.

Publisher Description

Linear Operators and Linear Systems

We solve a number of questions pertaining to the dynamics of linear operators on Hilbert spaces, sometimes by using Baire category arguments and sometimes by constructing explicit examples. In particular, we prove the following results. (i) A typical hypercyclic operator is not topologically mixing, has no eigen-values and admits no non-trivial invariant measure, but is densely distributionally chaotic. (ii) A typical upper-triangular operator with coefficients of modulus 1 on the diagonal is ergodic in the Gaussian sense, whereas a typical operator of the form "diagonal with coefficients of modulus 1 on the diagonal plus backward unilateral weighted shift" is ergodic but has only countably many unimodular eigenvalues; in particular, it is ergodic but not ergodic in the Gaussian sense. (iii) There exist Hilbert space operators which are chaotic and U-frequently hypercyclic but not frequently hypercyclic, Hilbert space operators which are chaotic and frequently hypercyclic but not ergodic, and Hilbert space operators which are chaotic and topologically mixing but not U-frequently hypercyclic. We complement our results by investigating the descriptive complexity of some natural classes of operators defined by dynamical properties.

Linear Dynamical Systems on Hilbert Spaces: Typical Properties and Explicit Examples

This volume contains short courses and recent papers by several specialists in different fields of Mathematical Analysis. It offers a wide perspective of the current state of research, and new trends, in areas related to Geometric Analysis, Harmonic Analysis, Complex Analysis, Functional Analysis and History of Mathematics. The contributions are presented with a remarkable expository nature and this makes the discussed topics accessible to a more general audience.

Advanced Courses Of Mathematical Analysis Vi - Proceedings Of The Sixth International School

This volume is part of the collaboration agreement between Springer and the ISAAC society. This is the first in the two-volume series originating from the 2020 activities within the international scientific conference "Modern Methods, Problems and Applications of Operator Theory and Harmonic Analysis" (OTHA), Southern Federal University in Rostov-on-Don, Russia. This volume is focused on general harmonic analysis and its numerous applications. The two volumes cover new trends and advances in several very important fields of mathematics, developed intensively over the last decade. The relevance of this topic is related to the study of complex multiparameter objects required when considering operators and objects with variable parameters.

Operator Theory and Harmonic Analysis

A comprehensive graduate textbook that introduces functional analysis with an emphasis on the theory of linear operators and its application to differential equations, integral equations, infinite systems of linear equations, approximation theory, and numerical analysis. As a textbook designed for senior undergraduate and graduate students, it begins with the geometry of Hilbert spaces and proceeds to the theory of linear operators on these spaces including Banach spaces. Presented as a natural continuation of linear algebra, the book provides a firm foundation in operator theory which is an essential part of mathematical training for students of mathematics, engineering, and other technical sciences.

Basic Classes of Linear Operators

One of the major unsolved problems in operator theory is the fifty-year-old invariant subspace problem, which asks whether every bounded linear operator on a Hilbert space has a nontrivial closed invariant subspace. This book presents some of the major results in the area, including many that were derived within the past few years and cannot be found in other books. Beginning with a preliminary chapter containing the necessary pure mathematical background, the authors present a variety of powerful techniques, including the use of the operator-valued Poisson kernel, various forms of the functional calculus, Hardy spaces, fixed point theorems, minimal vectors, universal operators and moment sequences. The subject is presented at a level accessible to postgraduate students, as well as established researchers. It will be of particular interest to those who study linear operators and also to those who work in other areas of pure mathematics.

Modern Approaches to the Invariant-Subspace Problem

Provides a graduate-level introduction to the theory of semigroups of operators.

Semigroups of Linear Operators

Blaschke Products and Their Applications presents a collection of survey articles that examine Blaschke products and several of its applications to fields such as approximation theory, differential equations, dynamical systems, harmonic analysis, to name a few. Additionally, this volume illustrates the historical roots of Blaschke products and highlights key research on this topic. For nearly a century, Blaschke products have been researched. Their boundary behaviour, the asymptotic growth of various integral means and their derivatives, their applications within several branches of mathematics, and their membership in different function spaces and their dynamics, are a few examples of where Blaschke products have shown to be important. The contributions written by experts from various fields of mathematical research will engage graduate students and researches alike, bringing the reader to the forefront of research in the topic. The readers will also discover the various open problems, enabling them to better pursue their own research.

Blaschke Products and Their Applications

This book contains the successful invited submissions to a Special Issue of Symmetry on the subject of “Graph Theory”. Although symmetry has always played an important role in Graph Theory, in recent years, this role has increased significantly in several branches of this field, including but not limited to Gromov hyperbolic graphs, the metric dimension of graphs, domination theory, and topological indices. This Special Issue includes contributions addressing new results on these topics, both from a theoretical and an applied point of view.

Symmetry in Graph Theory

A new approach to studying Fréchet geometry using projective limits of geometrical objects modelled on Banach spaces.

Geometry in a Fréchet Context

This wide ranging but self-contained account of the spectral theory of non-self-adjoint linear operators is ideal for postgraduate students and researchers, and contains many illustrative examples and exercises. Fredholm theory, Hilbert-Schmidt and trace class operators are discussed, as are one-parameter semigroups and perturbations of their generators. Two chapters are devoted to using these tools to analyze Markov semigroups. The text also provides a thorough account of the new theory of pseudospectra, and presents the recent analysis by the author and Barry Simon of the form of the pseudospectra at the boundary of the numerical range. This was a key ingredient in the determination of properties of the zeros of certain orthogonal polynomials on the unit circle. Finally, two methods, both very recent, for obtaining bounds on the eigenvalues of non-self-adjoint Schrödinger operators are described. The text concludes with a description of the surprising spectral properties of the non-self-adjoint harmonic oscillator.

Linear Operators and their Spectra

Advanced graduate-level treatment of semigroup theory explores semigroups of linear operators and linear Cauchy problems. The text features challenging exercises and emphasizes motivation, heuristics, and further applications. 1985 edition.

Semigroups of Linear Operators and Applications

This is the proceedings volume of an international conference entitled Complex Analysis and Potential Theory, which was held to honor the important contributions of two influential analysts, Kohur N. GowriSankaran and Paul M. Gauthier, in June 2011 at the Centre de Recherches Mathématiques (CRM) in Montreal. More than fifty mathematicians from fifteen countries participated in the conference. The twenty-four surveys and research articles contained in this book are based on the lectures given by some of the most established specialists in the fields. They reflect the wide breadth of research interests of the two honorees: from potential theory on trees to approximation on Riemann surfaces, from universality to inner and outer functions and the disc algebra, from branching processes to harmonic extension and capacities, from harmonic mappings and the Harnack principle to integration formulae in \mathbb{C}^n and the Hartogs phenomenon, from fine harmonicity and plurisubharmonic functions to the binomial identity and the Riemann hypothesis, and more. This volume will be a valuable resource for specialists, young researchers, and graduate students from both fields, complex analysis and potential theory. It will foster further cooperation and the exchange of ideas and techniques to find new research perspectives.

Complex Analysis and Potential Theory

The aim of this work is to present, in a unified and reasonably self-contained way, certain aspects of functional analysis which are needed to treat function spaces whose topology is not derived from a single norm, their topological duals and operators between those spaces. We treat spaces of continuous, analytic and smooth functions as well as sequence spaces. Operators of differentiation, integration, composition, multiplication and partial differential operators between those spaces are studied. A brief introduction to Laurent Schwartz's theory of distributions and to Lars Hörmander's approach to linear partial differential operators is presented. The novelty of our approach lies mainly on two facts. First of all, we show all these topics together in an accessible way, stressing the connection between them. Second, we keep it always at a level that is accessible to beginners and young researchers. Moreover, parts of the book might be of interest for researchers in functional analysis

and operator theory. Our aim is not to build and describe a whole, complete theory, but to serve as an introduction to some aspects that we believe are interesting. We wish to guide any reader that wishes to enter in some of these topics in their first steps. Our hope is that they learn interesting aspects of functional analysis and become interested to broaden their knowledge about function and sequence spaces and operators between them. The text is addressed to students at a master level, or even undergraduate at the last semesters, since only knowledge on real and complex analysis is assumed. We have intended to be as self-contained as possible, and wherever an external citation is needed, we try to be as precise as we can. Our aim is to be an introduction to topics in, or connected with, different aspects of functional analysis. Many of them are in some sense classical, but we tried to show a unified direct approach; some others are new. This is why parts of these lectures might be of some interest even for researchers in related areas of functional analysis or operator theory. There is a full chapter about transitive and mean ergodic operators on locally convex spaces. This material is new in book form. It is a novel approach and can be of interest for researchers in the area.

Function Spaces and Operators between them

Determining the invariant subspaces of any given transformation and writing the transformation as an integral in terms of invariant subspaces is a fundamental problem. This book presents the foundations of the theory of triangular and Jordan representations of bounded linear operators in Hilbert space and solves the problem in the case of completely continuous transformations. The reader is assumed to know the basics of linear operator theory.

Interpolation of Linear Operators

This volume presents a systematic treatment of the theory of unbounded linear operators in normed linear spaces with applications to differential equations. Largely self-contained, it is suitable for advanced undergraduates and graduate students, and it only requires a familiarity with metric spaces and real variable theory. After introducing the elementary theory of normed linear spaces--particularly Hilbert space, which is used throughout the book--the author develops the basic theory of unbounded linear operators with normed linear spaces assumed complete, employing operators assumed closed only when needed. Other topics include strictly singular operators; operators with closed range; perturbation theory, including some of the main theorems that are later applied to ordinary differential operators; and the Dirichlet operator, in which the author outlines the interplay between functional analysis and "hard" classical analysis in the study of elliptic partial differential equations. In addition to its readable style, this book's appeal includes numerous examples and motivations for certain definitions and proofs. Moreover, it employs simple notation, eliminating the need to refer to a list of symbols.

Triangular and Jordan Representations of Linear Operators

This book is a unique introduction to the theory of linear operators on Hilbert space. The authors' goal is to present the basic facts of functional analysis in a form suitable for engineers, scientists, and applied mathematicians. Although the Definition-Theorem-Proof format of mathematics is used, careful attention is given to motivation of the material covered and many illustrative examples are presented. First published in 1971, *Linear Operator in Engineering and Sciences* has since proved to be a popular and very useful textbook.

Linear Operators and Operator Equations

Some of the results on automatic continuity of intertwining operators and homomorphisms that were obtained between 1960 and 1973 are here collected together to provide a detailed discussion of the subject. The book will be appreciated by graduate students of functional analysis who already have a good foundation in this and in the theory of Banach algebras.

Unbounded Linear Operators

This collection of lectures treats the dynamics of open systems with a strong emphasis on dissipation phenomena related to dynamical chaos. This research area is very broad, covering topics such as nonequilibrium statistical mechanics, environment-system coupling (decoherence) and applications of Markov semi-groups to name but a few. The book addresses not only experienced researchers in the field but also nonspecialists from related areas of research, postgraduate students wishing to enter the field and lecturers searching for advanced textbook material.

Linear Operator Theory in Engineering and Science

This book is a slightly expanded reproduction of the first two chapters (plus Introduction) of my book *Perturbation Theory for Linear Operators*, Grundlehren der mathematischen Wissenschaften 132, Springer 1980. Ever since, or even before, the publication of the latter, there have been suggestions about separating the first two chapters into a single volume. I have now agreed to follow the suggestions, hoping that it will make the book available to a wider audience. Those two chapters were intended from the outset to be a comprehensive presentation of those parts of perturbation theory that can be treated without the topological complications of infinite-dimensional spaces. In fact, many essential and even advanced results in the theory have non-trivial contents in finite-dimensional spaces, although one should not forget that some parts of the theory, such as those pertaining to scattering, are peculiar to infinite dimensions. I hope that this book may also be used as an introduction to linear algebra. I believe that the analytic approach based on a systematic use of complex functions, by way of the resolvent theory, must have a strong appeal to students of analysis or applied mathematics, who are usually familiar with such analytic tools.

Automatic Continuity of Linear Operators

This book is dedicated to a theory of traces and determinants on embedded algebras of linear operators, where the trace and determinant are extended from finite rank operators by a limit process. The self-contained material should appeal to a wide group of mathematicians and engineers, and is suitable for teaching.

Linear Dynamical Systems

Authoritative text presenting a broad view of the spectral theory of non-self-adjoint linear operators.

Dynamics of Dissipation

The fundamental contributions made by the late Victor Lomonosov in several areas of analysis are revisited in this book, in particular, by presenting new results and future directions from world-recognized specialists in the field. The invariant subspace problem, Burnside's theorem, and the Bishop-Phelps theorem are discussed in detail. This volume is an essential reference to both researchers and graduate students in mathematical analysis.

A Short Introduction to Perturbation Theory for Linear Operators

Presents current research in various topics, including homogeneous dynamics, Diophantine approximation and combinatorics.

Traces and Determinants of Linear Operators

This set features: *Linear Operators, Part 1, General Theory* (978-0-471-60848-6), *Linear Operators, Part 2, Spectral Theory, Self Adjoint Operators in Hilbert Space* (978-0-471-60847-9), and *Linear Operators, Part 3, Spectral Operators* (978-0-471-60846-2), all by Neilson Dunford and Jacob T. Schwartz.

Linear Operators and Their Spectra

The book treats the theory of attractors for non-autonomous dynamical systems. The aim of the book is to give a coherent account of the current state of the theory, using the framework of processes to impose the minimum of restrictions on the nature of the non-autonomous dependence. The book is intended as an up-to-date summary of the field, but much of it will be accessible to beginning graduate students. Clear indications will be given as to which material is fundamental and which is more advanced, so that those new to the area can quickly obtain an overview, while those already involved can pursue the topics we cover more deeply.

The Mathematical Legacy of Victor Lomonosov

Constructs a theoretical framework for the study of linear relations and provides underlying concepts, rules, formulae, theorems and techniques. The book compares the inversion, adjoints, completion and closure of various classes of linear operators. It highlights compact and precompact relations.

Linear Operators: General theory

This is an collection of some easily-formulated problems that remain open in the study of the geometry and analysis of Banach spaces. Assuming the reader has a working familiarity with the basic results of Banach space theory, the authors focus on concepts of basic linear geometry, convexity, approximation, optimization, differentiability, renormings, weak compact generating, Schauder bases and biorthogonal systems, fixed points, topology and nonlinear geometry. The main purpose of this work is to help in convincing young researchers in Functional Analysis that the theory of Banach spaces is a fertile field of research, full of interesting open problems. Inside the Banach space area, the text should help expose young researchers to the depth and breadth of the work that remains, and to provide the perspective necessary to choose a direction for further study. Some of the problems are longstanding open problems, some are recent, some are more important and some are only local problems. Some would require new ideas, some may be resolved with only a subtle combination of known facts. Regardless of their origin or longevity, each of these problems documents the need for further research in this area.

Dynamics and Analytic Number Theory

This classic textbook by two mathematicians from the USSR's prestigious Kharkov Mathematics Institute introduces linear operators in Hilbert space, and presents in detail the geometry of Hilbert space and the spectral theory of unitary and self-adjoint operators. It is directed to students at graduate and advanced undergraduate levels, but because of the exceptional clarity of its theoretical presentation and the inclusion of results obtained by Soviet mathematicians, it should prove invaluable for every mathematician and physicist. 1961, 1963 edition.

Linear Operators Set

The theoretical part of this monograph examines the distribution of the spectrum of operator polynomials, focusing on quadratic operator polynomials with discrete spectra. The second part is devoted to applications. Standard spectral problems in Hilbert spaces are of the form $A - \lambda B$ for an operator A , and self-adjoint operators are of particular interest and importance, both theoretically and in terms of applications. A characteristic feature of self-adjoint operators is that their spectra are real, and many spectral problems in theoretical physics and engineering can be described by using them. However, a large class of problems, in particular vibration problems with boundary conditions depending on the spectral parameter, are represented by operator polynomials that are quadratic in the eigenvalue parameter and whose coefficients are self-adjoint operators. The spectra of such operator polynomials are in general no more real, but still exhibit certain patterns. The distribution of these spectra is the main focus of the present volume. For some classes of quadratic operator polynomials, inverse problems are also considered. The connection between the spectra of such quadratic operator polynomials and generalized Hermite-Biehler functions is discussed in detail. Many applications are thoroughly investigated, such as the Regge problem and damped vibrations of smooth strings, Stieltjes strings, beams, star graphs of strings and quantum graphs. Some chapters summarize advanced background material, which is supplemented with detailed proofs. With regard to the reader's background knowledge, only the basic properties of operators in Hilbert spaces and well-known results from complex analysis are assumed.

Attractors for infinite-dimensional non-autonomous dynamical systems

This book is dedicated to the mathematical study of two-dimensional statistical hydrodynamics and turbulence, described by the 2D Navier–Stokes system with a random force. The authors' main goal is to justify the statistical properties of a fluid's velocity field $u(t,x)$ that physicists assume in their work. They rigorously prove that $u(t,x)$ converges, as time grows, to a statistical equilibrium, independent of initial data. They use this to study ergodic properties of $u(t,x)$ – proving, in particular, that observables $f(u(t, \cdot))$ satisfy the strong law of large numbers and central limit theorem. They also discuss the inviscid limit when viscosity goes to zero, normalising the force so that the energy of solutions stays constant, while their Reynolds numbers grow to infinity. They show that then the statistical equilibria converge to invariant measures of the 2D Euler equation and study these measures. The methods apply to other nonlinear PDEs perturbed by random forces.

The Approximation of Continuous Functions by Positive Linear Operators

This book discusses the important aspects of spectral theory, in particular, the completeness of generalised eigenvectors, Riesz bases, semigroup theory, families of analytic operators, and Gribov

operator acting in the Bargmann space. Recent mathematical developments of perturbed non-self-adjoint operators are discussed with the completeness of the space of generalized eigenvectors, bases on Hilbert and Banach spaces and asymptotic behavior of the eigenvalues of these operators. Most results in the book are motivated by physical problems, such as the perturbation method for sound radiation by a vibrating plate in a light fluid, Gribov operator in Bargmann space and other applications in mathematical physics and mechanics. This book is intended for students, researchers in the field of spectral theory of linear non self-adjoint operators, pure analysts and mathematicians.

Multivalued Linear Operators

Open Problems in the Geometry and Analysis of Banach Spaces