Linear Operator Theory In Engineering And Science

Basic Operator Theory provides an introduction to functional analysis with an emphasis on the theory of linear operators and its application to differential and integral equations, approximation theory, and numerical analysis. A textbook designed for senior undergraduate and graduate students, Basic Operator Theory begins with the geometry of Hilbert space and proceeds to the spectral theory for compact self-adjoint operators with a wide range of applications. Part of the volume is devoted to Banach spaces and operators acting on these spaces. Presented as a natural continuation of linear algebra, Basic Operator Theory provides a firm foundation in operator theory, an essential part of mathematical training for students of mathematics, engineering, and other technical sciences.

Designed for advanced engineering, physical science, and applied mathematics students, this innovative textbook is an introduction to both the theory and practical application of linear algebra and functional analysis. The book is self-contained, beginning with elementary principles, basic concepts, and definitions. The important theorems of the subject are covered and effective application tools are developed, working up to a thorough treatment of eigenanalysis and the spectral resolution theorem. Building on a fundamental understanding of finite vector spaces, infinite dimensional Hilbert spaces are introduced from analogy. Wherever possible, theorems and definitions from matrix theory are called upon to drive the analogy home. The result is a clear and intuitive segue to functional analysis, culminating in a practical introduction to the functional theory of integral and differential operators. Numerous examples, problems, and illustrations highlight applications from all over engineering and the physical sciences. Also included are several numerical applications, complete with Mathematica solutions and code, giving the student a "hands-on" introduction to numerical analysis. Linear Algebra and Linear Operators in Engineering is ideally suited as the main text of an introductory graduate course, and is a fine instrument for self-study or as a general reference for those applying mathematics. Contains numerous Mathematica examples complete with full code and solutions Provides complete numerical algorithms for solving linear and nonlinear problems Spans elementary notions to the functional theory of linear integral and differential equations Includes over 130 examples, illustrations, and exercises and over 220 problems ranging from basic concepts to challenging applications Presents real-life applications from chemical, mechanical, and electrical engineering and the physical sciences

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.

Since the characterization of generators of C0 semigroups was established in the 1940s, semigroups of linear operators and its neighboring areas have developed into an abstract theory that has become a necessary discipline in functional analysis and differential equations. This book presents that theory and its basic applications, and the last two chapters give a connected account of the applications to partial differential equations.

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.

An operator theoretic approach to robust control analysis for linear time-varying systems, with the emphasis on the conceptual similarity with the H control theory for time-invariant systems. It clarifies the major difficulties confronted in the time varying case and all the necessary operator theory is developed from first principles, making the book as self-contained as possible. After presenting the necessary results from the theories of Toeplitz operators and nest algebras, linear systems are defined as input-output operators and the relationship between stabilisation and the existence of co-prime factorisations is described. Uniform optimal control problems are formulated as model-matching problems and are reduced to four block problems, while robustness is considered both from the point of view of fractional representations and the "time varying gap" metric, as is the relationship between these types of uncertainties. The book closes with the solution of the orthogonal embedding problem for time-varying contractive systems. As such, this book is useful to both mathematicians and to control engineers.

The book presents an introduction to the geometry of Hilbert spaces and operator theory, targeting graduate and senior undergraduate students of mathematics. Major topics discussed in the book are inner product spaces, linear operators, spectral theory and special classes of operators, and Banach spaces. On vector spaces, the structure of inner product is imposed. After discussing geometry of Hilbert spaces, its applications to diverse branches of mathematics have been studied. Along the way are introduced orthogonal polynomials and their use in Fourier series and approximations. Spectrum of an operator is the key to the understanding of the operator. Properties of the spectrum of different classes of operators, such as normal operators, self-adjoint operators, unitaries, isometries and compact operators have been discussed. A large number of examples of operators, along with their spectrum and its splitting into point spectrum, continuous spectrum, residual spectrum, approximate point spectrum and compression spectrum, have been worked out. Spectral theorems for self-adjoint operators, and normal operators, follow the spectral theorem for compact normal operators. The book also discusses invariant subspaces with special attention to the Volterra operator and unbounded operators. In order to make the text as accessible as possible, motivation for the topics is introduced and a greater amount of explanation than is usually found in standard texts on the subject is provided. The abstract theory in the book is supplemented with concrete examples. It is expected that these features will help the reader get a good grasp of the topics discussed. Hints and solutions to all the problems are collected at the end of the book. Additional features are introduced in the book when it becomes imperative. This spirit is kept alive throughout the book.

Functional analysis is a powerful tool when applied to mathematical problems arising from physical situations. The present book provides, by careful selection of material, a collection of concepts and techniques essential for the modern practitioner. Emphasis is placed on the solution of equations (including nonlinear and partial differential equations). The assumed background is limited to elementary real variable theory and finite-dimensional vector spaces. Provides an ideal transition between introductory math courses and advanced graduate study in applied mathematics, the physical sciences, or engineering Gives the reader a keen understanding of applied functional analysis, building progressively from simple background material to the deepest and most significant results Introduces each new topic with a clear, concise explanation Includes numerous examples linking fundamental principles with applications Solidifies the reader's understanding with numerous end-of-chapter problems

Linear systems can be regarded as a causal shift-invariant operator on a Hilbert space of signals, and by doing so this book presents an introduction to the common ground between operator theory and linear systems theory. The book therefore includes material on pure mathematical topics such as Hardy spaces, closed operators, the gap metric, semigroups, shift-invariant subspaces, the commutant lifting theorem and almost-periodic functions, which would be entirely suitable for a course in functional analysis; at the same time, the book includes applications to partial differential equations, to the stability and stabilization of linear systems, to power signal spaces (including some recent material not previously available in books), and to delay systems, treated from an input/output point of view. Suitable for students of analysis, this book also acts as an introduction to a mathematical approach to systems and control for graduate students in departments of applied mathematics or engineering.

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.

The vast and rapid advancement in telecommunications, computers, controls, and aerospace science has necessitated major changes in our basic understanding of the theory of electrical signals and processing systems. There is strong evidence that today's engineer needs to extend and to modernize his analytical techniques. The latest fundamental analytical approach for the study of signals and systems seems to have its roots in the mathematics of Functional Analysis. This report contains a bird's-eye view of the elements of Hilbert spaces and their associated linear operators. The first chapter of the report gives an exposition of the most essential properties of Hilbert spaces. The second chapter presents the elements of linear operators acting on such spaces. The report is addressed to engineers and scientists interested in the theory of signals and systems. The applications of the theory will be undertaken in a separate report. (Author).

This book presents a panorama of operator theory. It treats a variety of classes of linear operators which illustrate the richness of the theory, both in its theoretical developments and its applications. For each of the classes various differential and integral operators motivate or illustrate the main results. The topics have been updated and enhanced by new developments, many of which appear here for the first time. Interconnections appear frequently and unexpectedly. This second volume consists of five parts: triangular representations, classes of Toeplitz operators, contractive operators and characteristic operator functions, Banach algebras and algebras of operators, and extension and completion problems. The exposition is self-contained and has been simplified and polished in an effort to make advanced topics accessible to a wide audience of students and researchers in mathematics, science and engineering. Contents: Vol. I - This book presents a panorama of operator theory. It treats a variety of classes of linear operators which illustrate the richness of the theory, both in its theoretical developments and its applications. For each of the classes various differential and integral operators motivate or illustrate the main results. The topics have been updated and enhanced by new developments, many of which appear here for the first time. Interconnections appear frequently and unexpectedly. The present volume consists of four parts: general spectral theory, classes of compact operators, Fredholm and Wiener-Hopf operators, and classes of unbounded operators: The exposition is self-contained and has been simplified and polished in an effort to make advanced topics accessible to a wide audience of students and researchers in mathematics, science and engineering. ..". Used as a graduate textbook, the book allows the instructor several good selections of topics to build a course. ... The authors took great care to polish and simplify the exposition; as a result, the book can serve also as an excellent basis for reading courses or for self-study. ... Besides being a textbook, the book is a valuable reference source for a wide audience of mathematicians, physicists and engineers. The specialists in functional analysis and operator theory will find most of the topics familiar, although the exposition is often novel or non-traditional, making the material more accessible. ..." (Zentralblatt fA1/4r Mathematik) / "This book presents an excellently chosen panorama of operator theory. It shows for several times the fruitful application of complex analysis to problems in operator theory. ... Each part contains interesting exercises and

comments on the literature of the topic." (Monatshefte fA1/4r Mathematik)
This monograph only requires of the reader a basic knowledge of classical analysis: measure theory, analytic functions, Hilbert spaces, functional analysis. The book is self-contained, except for a few technical tools, for which precise references are given. Part I starts with finite-dimensional spaces and general spectral theory. But very soon (Chapter III), new material is presented, leading to new directions for research. Open questions are mentioned here. Part II concerns compactness and its applications, not only spectral theory for compact operators (Invariant Subspaces and Lomonossov's Theorem) but also duality between the space of nuclear operators and the space of all operators on a Hilbert space, a result which is seldom presented. Part III contains Algebra Techniques: Gelfand's Theory, and application to Normal Operators. Here again, directions for research are indicated. Part IV deals with analytic functions, and contains a few new developments. A simplified, operator-oriented, version is presented. Part V presents dilations and extensions: Nagy-Foias dilation theory, and the author's work about C1-contractions. Part VI deals with the Invariant Subspace Problem, with positive results and counter-examples. In general, much new material is presented. On the Invariant Subspace Problem, the level of research is reached, both in the positive and negative directions.
This book gathers contributions written by Daniel Alpay’s friends and collaborators. Several of the papers were presented at the International Conference on Complex Analysis and Operator Theory held in honor of Professor Alpay’s 60th birthday at Chapman University in November 2016. The main topics covered are complex analysis, operator theory and other areas of mathematics close to Alpay’s primary research interests. The book is recommended for mathematicians from the graduate level on, working in various areas of mathematical analysis, operator theory, infinite dimensional analysis, linear systems, and stochastic processes.
The theory of semigroups of operators is one of the most important themes in modern analysis. Not only does it have great intellectual beauty, but also wide-ranging applications. In this book the author first presents the essential elements of the theory, introducing the notions of semigroup, generator and resolvent, and establishes the key theorems of Hille–Yosida and Lumer–Phillips that give conditions for a linear operator to generate a semigroup. He then presents a mixture of applications and further developments of the theory. This includes a description of how semigroups are used to solve parabolic partial differential equations, applications to Levy and Feller–Markov processes, Koopmanism in relation to dynamical systems, quantum dynamical semigroups, and applications to generalisations of the Riemann–Liouville fractional integral. Along the way the reader encounters several important ideas in modern analysis including Sobolev spaces, pseudo-differential operators and the Nash inequality.
This book expands the lectures given at a regional conference in Lincoln, Nebraska which brought together a wide variety of scientists, pure

mathematicians and engineers.

This book represents the first synthesis of the considerable body of new research into positive definite matrices. These matrices play the same role in noncommutative analysis as positive real numbers do in classical analysis. They have theoretical and computational uses across a broad spectrum of disciplines, including calculus, electrical engineering, statistics, physics, numerical analysis, quantum information theory, and geometry. Through detailed explanations and an authoritative and inspiring writing style, Rajendra Bhatia carefully develops general techniques that have wide applications in the study of such matrices. Bhatia introduces several key topics in functional analysis, operator theory, harmonic analysis, and differential geometry--all built around the central theme of positive definite matrices. He discusses positive and completely positive linear maps, and presents major theorems with simple and direct proofs. He examines matrix means and their applications, and shows how to use positive definite functions to derive operator inequalities that he and others proved in recent years. He guides the reader through the differential geometry of the manifold of positive definite matrices, and explains recent work on the geometric mean of several matrices. Positive Definite Matrices is an informative and useful reference book for mathematicians and other researchers and practitioners. The numerous exercises and notes at the end of each chapter also make it the ideal textbook for graduate-level courses.

The most commonly used numerical techniques in solving engineering and mathematical models are the Finite Element, Finite Difference, and Boundary Element Methods. As computer capabilities continue to impro':e in speed, memory size and access speed, and lower costs, the use of more accurate but computationally expensive numerical techniques will become attractive to the practicing engineer. This book presents an introduction to a new approximation method based on a generalized Fourier series expansion of a linear operator equation. Because many engineering problems such as the multi dimensional Laplace and Poisson equations, the diffusion equation, and many integral equations are linear operator equations, this new approximation technique will be of interest to practicing engineers. Because a generalized Fourier series is used to develop the approxi mator, a "best approximation" is achieved in the "least-squares" sense; hence the name, the Best Approximation Method. This book guides the reader through several mathematics topics which are pertinent to the development of the theory employed by the Best Approximation Method. Working spaces such as metric spaces and Banach spaces are explained in readable terms. Integration theory in the Lebesque sense is covered carefully. Because the generalized Fourier series utilizes Lebesque integration concepts, the integra tion theory is covered through the topic of converging sequences of functions with respect to measure, in the mean (Lp), almost uniformly IV and almost everywhere. Generalized Fourier theory and linear operator theory are treated in Chapters 3 and 4.

This book is an introduction to the subject and is devoted to standard material on linear functional analysis, and presents some ergodic theorems for classes of operators containing the quasi-compact operators. It discusses various classes of operators connected with the numerical range.

Random Operator Theory provides a comprehensive discussion of the random norm of random bounded linear operators, also providing important random norms as random norms of differentiation operators and integral operators. After providing the basic definition of random norm of random bounded linear operators, the book then delves into the study of random operator theory, with final sections discussing the concept of random Banach algebras and its applications. Explores random differentiation and random integral equations Delves into the study of random operator theory Discusses the concept of random Banach algebras and its applications

rii application of linear operators on a Hilbert space. We begin with a chapter on the geometry of Hilbert space and then proceed to the spectral theory of compact self adjoint operators; operational calculus is next presented as a nat ural outgrowth of the spectral theory. The second part of the text concentrates on Banach spaces and linear operators acting on these spaces. It includes, for example, the three 'basic principles of linear analysis and the Riesz Fredholm theory of compact operators. Both parts contain plenty of applications. All chapters deal exclusively with linear problems, except for the last chapter which is an introduction to the theory of nonlinear operators. In addition to the standard topics in functional anal ysis, we have presented relatively recent results which appear, for example, in Chapter VII. In general, in writ ing this book, the authors were strongly influenced by re cent developments in operator theory which affected the choice of topics, proofs and exercises. One of the main features of this book is the large number of new exercises chosen to expand the reader's com prehension of the material, and to train him or her in the use of it. In the beginning portion of the book we offer a large selection of computational exercises; later, the proportion of exercises dealing with theoretical questions increases. We have, however, omitted exercises after Chap ters V, VII and XII due to the specialized nature of the subject matter.

This text discusses electromagnetics from the view of operator theory, in a manner more commonly seen in textbooks of quantum mechanics. It includes a self-contained introduction to operator theory, presenting definitions and theorems, plus proofs of the theorems when these are simple or enlightening.

{\it Elements of Operatory Theory} is aimed at graduate students as well as a new generation of mathematicians and scientists who need to apply operator theory to their field. Written in a user-friendly, motivating style, fundamental topics are presented in a systematic fashion, i.e., set theory, algebraic structures, topological structures, Banach spaces, Hilbert spaces, culminating with the Spectral Theorem, one of the landmarks in the theory of operators on Hilbert spaces. The exposition is concept-driven and as much as possible avoids the formula-computational approach. Key features of this largely self-contained work include: * required background material to each chapter * fully rigorous proofs, over 300 of them, are specially tailored to the presentation and some are new * more than 100 examples and, in several cases, interesting counterexamples that demonstrate the frontiers of an important theorem * over 300 problems, many with hints * both problems and examples underscore further auxiliary results and extensions of the main theory; in this non-traditional framework, the reader is challenged and has a chance to prove the principal theorems anew This work is an excellent text for the classroom as well as a self-study resource for researchers. Prerequisites include an introduction to analysis and to functions of a complex variable, which most first-year graduate students in mathematics, engineering, or another formal science have already acquired. Measure theory and integration theory are required only for the last section of the final chapter.

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.

Linear Operator Theory in Engineering and ScienceSpringer Science & Business Media

Nobel prize winner Ilya Prigogine writes in his preface: "Irreversibility is a challenge to mathematics...[which] leads to generalized functions and to an extension of spectral analysis beyond the conventional Hilbert space theory." Meeting this challenge required new mathematical formulations-obstacles met and largely overcome thanks primarily to the contributors to this volume." This compilation of works grew out of material presented at the "Hyperfunctions, Operator Theory and Dynamical Systems" symposium at the International Solvay Institutes for Physics and Chemistry in 1997. The result is a coherently organized collective work that moves from general, widely applicable mathematical methods to ever more specialized physical applications. Presented in two sections, part one describes Generalized Functions and Operator Theory, part two addresses Operator Theory and Dynamical Systems. The interplay between mathematics and physics is now more necessary than ever-and more difficult than ever, given the increasing complexity of theories and methods.

Most books on linear operators are not easy to follow for students and researchers without an extensive background in mathematics. Self-contained and using only matrix theory, Invitation to Linear Operators: From Matricies to Bounded Linear Operators on a Hilbert Space explains in easy-to-follow steps a variety of interesting recent results on linear operators on a Hilbert space. The author first states the important properties of a Hilbert space, then sets out the fundamental properties of bounded linear operators on a Hilbert space. The final section presents some of the more recent developments in bounded linear operators.

This book offers a comprehensive and reader-friendly exposition of the theory of linear operators on Banach spaces and Banach lattices. Abramovich and Aliprantis give a unique presentation that includes many new developments in operator theory and also draws together results that are spread over the vast literature. For instance, invariant subspaces of positive operators and the Daugavet equation are presented in monograph form for the first time. The authors keep the discussion self-contained and use exercises to achieve this goal. The book contains over 600 exercises to help students master the material developed in the text. The exercises are of varying degrees of difficulty and play an important and useful role in the exposition. They help to free the proofs of the main results of some technical details but provide students with accurate and complete accounts of how such details ought to be worked out.The exercises also contain a considerable amount of additional material that includes many well-known results whose proofs are not readily available elsewhere. The companion volume, ""Problems in Operator Theory"", also by Abramovich and Aliprantis, is available from the AMS as Volume 51 in the ""Graduate Studies in Mathematics"" series, and it contains complete solutions to all exercises in ""An Invitation to Operator Theory"". The solutions demonstrate explicitly technical details in the proofs of many results in operator theory, providing the reader with rigorous and complete accounts of such details. Finally, the book offers a considerable amount of additional material and further developments.By adding extra material to many exercises, the authors have managed to keep the presentation as self-contained as possible. The best way of learning mathematics is by doing mathematics, and the book ""Problems in Operator Theory"" will help achieve this goal. Prerequisites to each book are the standard introductory graduate courses in real analysis, general topology, measure theory, and functional analysis. ""An Invitation to Operator Theory"" is suitable for graduate or advanced courses in operator theory, real analysis, integration theory, measure theory, function theory, and functional analysis. ""Problems in Operator Theory"" is a very useful supplementary text in the above areas. Both books will be of great interest to researchers and students in mathematics, as well as in physics, economics, finance,

engineering, and other related areas, and will make an indispensable reference tool.
By a Hilbert-space operator we mean a bounded linear transformation be tween separable complex Hilbert spaces. Decompositions and models for Hilbert-space operators have been very active research topics in operator theory over the past three decades. The main motivation behind them is the in variant subspace problem: does every Hilbert-space operator have a nontrivial invariant subspace? This is perhaps the most celebrated open question in op erator theory. Its relevance is easy to explain: normal operators have invariant subspaces (witness: the Spectral Theorem), as well as operators on finite dimensional Hilbert spaces (witness: canonical Jordan form). If one agrees that each of these (i. e. the Spectral Theorem and canonical Jordan form) is important enough an achievement to dismiss any further justification, then the search for nontrivial invariant subspaces is a natural one; and a recalcitrant one at that. Subnormal operators have nontrivial invariant subspaces (extending the normal branch), as well as compact operators (extending the finite-dimensional branch), but the question remains unanswered even for equally simple (i. e. simple to define) particular classes of Hilbert-space operators (examples: hyponormal and quasinilpotent operators). Yet the invariant subspace quest has certainly not been a failure at all, even though far from being settled. The search for nontrivial invariant subspaces has undoubtly yielded a lot of nice results in operator theory, among them, those concerning decompositions and models for Hilbert-space operators. This book contains nine chapters.
This volume contains the proceedings of the Workshop on app1ications of linear operator theory to systems and networks, which was held at the Weizmann Institute of Science in the third week of June, 19S3,just be fore the MTNS Conference in Beersheva. For a 10ng time these subjects were studied indepen dent1y by mathematica1 ana1ysts and e1ectrica1 engineers. Never the1ess, in spite of the lack of communication, these two groups often deve10ped parallel theories, though in different languages, at different levels of genera1ity and typica11y quite different motivations. In the last severa1 years each side has become aware of the work of the other and there is a seeming1y ever increasing invo1vement of the abstract theories of factorization, extension and interpolation of operators (and operator/matrix va1ued functions) to the design and analysis of systems and net works. Moreover, the problems encountered in e1ectrica1 engineering have genera ted new mathematica1 problems, new approaches, and usefu1 new formu1ations. The papers contained in this volume constitute a more than representative se1ection of the presented talks and dis cussion at the workshop, and hopefu11y will also serve to give a reasonably accurate picture of the problems which are under active study today and the techniques which are used to deal with them.
Based largely on state space models, this text/reference utilizes fundamental linear algebra and operator techniques to develop classical and modern results in linear systems analysis and control design. It presents stability and performance results for linear systems, provides a geometric perspective on controllability and observability, and develops state space realizations of transfer functions. It also studies stabilizability and detectability, constructs state feedback controllers and asymptotic state estimators, covers the linear quadratic regulator problem in detail, introduces H-infinity control, and presents results on Hamiltonian matrices and Riccati equations.

This book provides a broad overview of state-of-the-art research at the intersection of the Koopman operator theory and control theory. It also reviews novel theoretical results obtained and efficient numerical methods developed within the framework of Koopman operator theory. The contributions discuss the latest findings and techniques in several areas of control theory, including model predictive control, optimal control, observer design, systems identification and structural analysis of controlled systems, addressing both theoretical and numerical aspects and presenting open research directions, as well as detailed numerical schemes and data-driven methods. Each contribution addresses a specific problem. After a brief introduction of the Koopman operator framework, including basic notions and definitions, the book explores numerical methods, such as the dynamic mode decomposition (DMD) algorithm and Arnoldi-based methods, which are used to represent the operator in a finite-dimensional basis and to compute its spectral properties from data. The main body of the book is divided into three parts: theoretical results and numerical techniques for observer design, synthesis analysis, stability analysis, parameter estimation, and identification; data-driven techniques based on DMD, which extract the spectral properties of the Koopman operator from data for the structural analysis of controlled systems; and Koopman operator techniques with specific applications in systems and control, which range from heat transfer analysis to robot control. A useful reference resource on the Koopman operator theory for control theorists and practitioners, the book is also of interest to graduate students, researchers, and engineers looking for an introduction to a novel and comprehensive approach to systems and control, from pure theory to data-driven methods.

Presenting excellent material for a first course on functional analysis , Functional Analysis in Applied Mathematics and Engineering concentrates on material that will be useful to control engineers from the disciplines of electrical, mechanical, and aerospace engineering. This text/reference discusses: rudimentary topology Banach's fixed point theorem with applications L^p-spaces density theorems for testfunctions infinite dimensional spaces bounded linear operators Fourier series open mapping and closed graph theorems compact and differential operators Hilbert-Schmidt operators Volterra equations Sobolev spaces control theory and variational analysis Hilbert Uniqueness Method boundary element methods Functional Analysis in Applied Mathematics and Engineering begins with an introduction to the important, abstract basic function spaces and operators with mathematical rigor, then studies problems in the Hilbert space setting. The author proves the spectral theorem for unbounded operators with compact inverses and goes on to present the abstract evolution semigroup theory for time dependent linear partial differential operators. This structure establishes a firm foundation for the more advanced topics discussed later in the text.

The book is intended as a text for a one-semester graduate course in operator theory to be taught "from scratch", not as a sequel to a functional analysis course, with the basics of the spectral theory of linear operators taking the center stage. The book consists of six chapters and appendix, with the material flowing from the fundamentals of abstract spaces (metric, vector, normed vector, and inner product), the Banach Fixed-Point Theorem and its applications, such as Picard's Existence and Uniqueness Theorem, through the basics of linear operators, two of the three fundamental principles (the Uniform Boundedness Principle and the Open Mapping Theorem and its equivalents: the Inverse Mapping and Closed Graph Theorems), to the elements of the spectral theory, including Gelfand's Spectral Radius Theorem and the Spectral Theorem for Compact Self-Adjoint Operators, and its applications, such as the celebrated Lyapunov Stability Theorem. Conceived as a text to be used in a classroom, the book constantly calls for the student's actively mastering the knowledge of the subject matter. There are problems at the end of each chapter, starting with Chapter 2 and totaling at 150. Many important statements are given as problems and frequently referred to in the main body. There are also 432 Exercises throughout the text, including Chapter 1 and the Appendix, which require of the student to prove or verify a statement or an example, fill in certain details in a proof, or provide an intermediate step or a counterexample. They are also an inherent part of the material. More difficult problems are marked with an asterisk, many problems and exercises are supplied with "existential" hints. The book is generous on Examples and contains numerous Remarks accompanying definitions, examples, and statements to discuss certain subtleties, raise questions on whether the converse assertions are true, whenever appropriate, or whether the conditions are essential. With carefully chosen material, proper attention given to applications, and plenty of examples, problems, and exercises, this well-designed text is ideal for a one-semester Master's level graduate course in operator theory with emphasis on spectral theory for students majoring in mathematics, physics, computer science, and engineering. Contents Preface Preliminaries Metric Spaces Vector Spaces, Normed Vector Spaces, and Banach Spaces Linear Operators Elements of Spectral Theory in a Banach Space Setting Elements of Spectral Theory in a Hilbert Space Setting Appendix: The Axiom of Choice and Equivalents Bibliography Index

Nonlinear analytic mappings. Nonlinear Lipschitz operators. Nonlinear feedback systems. Optimal design of nonlinear feedback control systems. Coprime factorizations of nonlinear mappings for control systems. Nonlinear system identification.

This book presents an introduction to the common ground between operator theory and linear systems theory. Suitable for students of functional analysis, this book also acts as an introduction to a mathematical approach to systems and control for graduate students in departments of applied mathematics or engineering.

This book is intended to be a comprehensive introduction to the subject of partial differential equations. It should be useful to graduate students at all levels beyond that of a basic course in measure theory. It should also be of interest to professional mathematicians in analysis, mathematical physics, and differential geometry. This work will be divided into three volumes, the first of which focuses on the theory of ordinary differential equations and a survey of basic linear PDEs.