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Hilbert Space, Boundary Value Problems and Orthogonal Polynomials - Allan M. Krall - 2012-12-06

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Boundary Value Problems for an Equation in a Hilbert Space - S. G. KREYN - 1962

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Boundary Value Problems, Weyl Functions, and Differential Operators - Jussi Behrndt - 2020-01-03

This open access book presents a comprehensive survey of modern operator techniques for boundary value problems and spectral theory, employing abstract boundary mappings and Weyl functions. It includes self-contained treatments of the extension theory of symmetric operators and relations, spectral characterizations of selfadjoint operators in terms of the analytic properties of Weyl functions, form methods for semibounded operators, and functional analytic models for reproducing kernel Hilbert spaces. Further, it illustrates these abstract methods for various applications, including Sturm-Liouville operators, canonical systems of differential equations, and multidimensional Schrödinger operators, where the abstract Weyl function appears as either the classical...
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**Multi-Interval Linear Ordinary Boundary Value Problems and Complex Symplectic Algebra** - William Norrie Everitt - 2001
A multi-interval quasi-differential system $\{I_r, M_r, w_r: r \in \Omega$
this paper a system Hilbert of real intervals, \$\{I_{\{r\}}\}\$, as indexed by a finite, or possibly infinite index set \$\Omega$ (where \$\mathrm{card}(\Omega)\geq\aleph_{0}\$ is permissible), on which are assigned ordinary or quasi-differential expressions \$M_{\{r\}}\$ generating unbounded operators in the Hilbert function spaces \$L_{\{r\}}\wedge\{2\}\equiv L^{2}(I_{\{r\}};w_{\{r\}})\$, where \$w_{\{r\}}\$ are given, non-negative weight functions. For each fixed \$r\in\Omega\$ assume that \$M_{\{r\}}\$ is Lagrange symmetric (formally self-adjoint) on \$I_{\{r\}}\$ and hence specifies minimal and maximal closed operators \$T_{\{0,r\}}\$ and \$T_{\{1,r\}}\$, respectively, in \$L_{\{r\}}\wedge\{2\}\$. However the theory does not require that the corresponding deficiency indices \$d_{\{r\}}^{-}\$ and \$d_{\{r\}}^{+}\$ of \$T_{\{0,r\}}\$ are equal (e. g. the symplectic excess \$Ex_{\{r\}}=d_{\{r\}}^{+}-d_{\{r\}}^{-}\neq 0\$), in which case there will not exist any self-adjoint extensions of \$T_{\{0,r\}}\$ in \$L_{\{r\}}\wedge\{2\}\$. In space \$\mathbf{H}:=\sum_{r\in\Omega}\oplus L_{\{r\}}\wedge\{2\}\$ is defined (even for non-countable \$\Omega\$) with corresponding minimal and maximal system operators \$\mathbf{T}_{\{0\}}\$ and \$\mathbf{T}_{\{1\}}\$ in \$\mathbf{H}\$. Then the system deficiency indices \$\mathbf{d}^{\pm}=\sum_{r\in\Omega}d_{\{r\}}^{\pm}\$ are equal (system symplectic excess \$Ex=0\$), if and only if there exist self-adjoint extensions \$\mathbf{T}\$ of \$\mathbf{T}_{\{0\}}\$ in \$\mathbf{H}\$. The existence is shown of a natural bijective correspondence between the set of all such self-adjoint extensions \$\mathbf{T}\$ of \$\mathbf{T}_{\{0\}}\$, and the set of all complete Lagrangian subspaces \$\mathsf{L}\$ of the system boundary complex symplectic space \$\mathsf{S}=\mathbf{D(T}_{\{1\}})/\mathbf{D(T}_{\{0\}}\$. This result generalizes the earlier symplectic version of the celebrated GKN-Theorem for single interval systems to
Examples of such complete Lagrangians, for both finite and infinite dimensional complex symplectic $\mathsf{S}$, illuminate new phenomena for the boundary value problems of multi-interval systems. These concepts have applications to many-particle systems of quantum mechanics, and to other physical problems.

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A multi-interval quasi-differential system $\{I_{r},M_{r},w_{r}:r:\in\Omega\}$ consists of a collection of real intervals, $\{I_{r}\}$, as indexed by a finite, or possibly infinite index set $\Omega$ (where $\mathrm{card}(\Omega)\geq\aleph_{0}$ is permissible), on which are assigned ordinary or quasi-differential expressions $M_{r}$ generating unbounded operators in the Hilbert function spaces $L_{r}^{2} \equiv L^{2}(I_{r};w_{r})$, where $w_{r}$ are given, non-negative weight functions. For each fixed $r:\in\Omega$ assume that $M_{r}$ is Lagrange symmetric (formally self-adjoint) on $I_{r}$ and hence specifies minimal and maximal closed operators $T_{0,r}$ and $T_{1,r}$, respectively, in $L_{r}^{2}$. However the theory does not require that the corresponding deficiency indices $d_{r}^{-}$ and $d_{r}^{+}$ of $T_{0,r}$ are equal (e.g. the symplectic excess $Ex_{r}=d_{r}^{+}-d_{r}^{-}\neq 0$), in which case there will not exist any self-adjoint extensions of $T_{0,r}$ in $L_{r}^{2}$. In this paper a system Hilbert space $\mathbf{H}:=\sum_{r:\in\Omega} L_{r}^{2}$ is defined (even for non-countable $\Omega$) with corresponding minimal and maximal system operators $\mathbf{T}_{0}$ and $\mathbf{T}_{1}$ in $\mathbf{H}$. Then the system deficiency indices $\mathbf{d}^{\pm} = \sum_{r:\in\Omega} d_{r}^{\pm}$ are given, non-negative weight functions. For each fixed $r:\in\Omega$ assume that $M_{r}$ is Lagrange symmetric (formally self-adjoint) on $I_{r}$ and hence specifies minimal and maximal closed operators $T_{0,r}$ and $T_{1,r}$, respectively, in $L_{r}^{2}$. However the theory does not require that the corresponding deficiency indices $d_{r}^{-}$ and $d_{r}^{+}$ of $T_{0,r}$ are equal (e.g. the symplectic excess $Ex_{r}=d_{r}^{+}-d_{r}^{-}\neq 0$), in which case there will not exist any self-adjoint extensions of $T_{0,r}$ in $L_{r}^{2}$. In this paper a system Hilbert space $\mathbf{H}:=\sum_{r:\in\Omega} L_{r}^{2}$ is defined (even for non-countable $\Omega$) with corresponding minimal and maximal system operators $\mathbf{T}_{0}$ and $\mathbf{T}_{1}$ in $\mathbf{H}$. Then the system deficiency indices $\mathbf{d}^{\pm} = \sum_{r:\in\Omega} d_{r}^{\pm}$.
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It is well known that two hermitian $n \times n$ matrices $K, H$, where $H$ is positive definite, $H > 0$, can be simultaneously diagonalized. The key to the proof is to consider $C^n$, where $C$ is the complex number field, as a Hilbert space $\mathcal{H}$, with the inner product given by $(f, g) = g^* H f$, where $f, g$ are column vectors. Then the operator $A = H^{-1} K$ is selfadjoint in $\mathcal{H}$, and the spectral theorem readily
yields the result. Of course such A, when K is not hermitian, can also be investigated in $\mathcal{H}_H$. We consider a similar problem where $K, H$ are replaced by a pair of ordinary differential expressions $L$ and $M$, where $M > 0$ in some sense. Two difficulties arise: (1) there are many natural choices for a selfadjoint $H > 0$ generated by $M$, and hence many choices for $[\mathcal{H}_H]$, and (2), once a choice for $H$ has been made, there are many choices for the analogue of $A$. In our work we consider all possible choices for $H > 0$ and the analogue of $A$.


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Functional Analysis and Boundary-value Problems - B. Dayanand Reddy - 1986

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Approximate Solution of Elliptic and Parabolic Boundary Value Problems - Jerome John Blair - 1970

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Hilbert Space Methods and Elliptic Boundary Value Problems - Kenneth Joseph Brown - 1971

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Elliptic and Parabolic Boundary Value Problems - Lambertus A. Peletier - 1978

Elliptic and Parabolic
Partial Differential Equations - Aleksei A. Dezin - 2012-12-06
Let me begin by explaining the meaning of the title of this book. In essence, the book studies boundary value problems for linear partial differential equations in a finite domain in n-dimensional Euclidean space. The problem that is investigated is the question of the dependence of the nature of the solvability of a given equation on the way in which the boundary conditions are chosen, i.e. on the supplementary requirements which the solution is to satisfy on specified parts of the boundary. The branch of mathematical analysis dealing with the study of boundary value problems for partial differential equations is often called mathematical physics. Classical courses in this subject usually consider quite restricted classes of equations, for which the problems have an immediate physical context, or
In this book, we study specified parts of the boundary. The branch of mathematical analysis dealing with the study of boundary value problems for partial differential equations is often called mathematical physics. Classical courses in this subject usually consider quite restricted classes of equations, for which the problems have an immediate physical context, or generalizations of such problems. With the expanding domain of application of mathematical methods at the present time, there often arise problems connected with the study of partial differential equations that do not belong to any of the classical types. The elucidation of the correct formulation of these problems and the study of the specific properties of the solutions of similar equations are closely related to the study of questions of a general nature.

**Initial Value Methods for Boundary Value Problems: Theory and Application of Invariant Imbedding** - - 1973-08-15

Theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and
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**Parabolic Boundary Value Problems** - Samuil D. Eidelman - 2012-12-06
compare different results and devoted to the theory of general parabolic boundary value problems. The vastness of this theory forced us to take difficult decisions in selecting the results to be presented and in determining the degree of detail needed to describe their proofs. In the first chapter we define the basic notions at the origin of the theory of parabolic boundary value problems and give various examples of illustrative and descriptive character. The main part of the monograph (Chapters II to V) is devoted to a detailed and systematic exposition of the L-theory of parabolic boundary value problems with smooth coefficients in Hilbert spaces of smooth functions and distributions of arbitrary finite order and with some natural applications of the theory. Wishing to make the monograph more informative, we included in Chapter VI a survey of results in the theory of the Cauchy problem and boundary value problems in the traditional spaces of smooth functions. We give no proofs; rather, we attempt to techniques. Special attention is paid to a detailed analysis of examples illustrating and complementing the results formulated. The chapter is written in such a way that the reader interested only in the results of the classical theory of the Cauchy problem and boundary value problems may concentrate on it alone, skipping the previous chapters.

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### Hörmander Spaces, Interpolation, and Elliptic Problems

Hörmander Spaces, Interpolation, and Elliptic Problems - Vladimir A. Mikhailets - 2014-07-14

The monograph gives a detailed exposition of the theory of general elliptic operators (scalar and matrix) and elliptic boundary value problems in Hilbert scales of Hörmander function spaces. This theory was constructed by the authors in a number of papers published in 2005–2009. It is distinguished by a systematic use of the method of interpolation with a functional parameter of abstract Hilbert spaces and Sobolev inner product spaces. This method, the theory and their applications are expounded for the first time in the monographic literature. The monograph is written in detail and in a reader-friendly style. The complete proofs of theorems are given. This monograph is intended for a wide range of mathematicians whose research interests concern with mathematical analysis and differential equations.
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Finite Element Solution of Boundary Value Problems - O. Axelsson - 1984-01-01
Finite Element Solution of Boundary Value Problems: Theory and Computation provides a thorough, balanced introduction to both the theoretical and the computational aspects of the finite element method for solving boundary value problems for partial differential equations. Although significant advances
problems for partial element method since this book first appeared in 1984, the basics have remained the same, and this classic, well-written text explains these basics and prepares the reader for more advanced study. Useful as both a reference and a textbook, complete with examples and exercises, it remains as relevant today as it was when originally published. Audience: this book is written for advanced undergraduate and graduate students in the areas of numerical analysis, mathematics, and computer science, as well as for theoretically inclined practitioners in engineering and the physical sciences.

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Providing an introduction to functional analysis, this text treats in detail its application to boundary-value problems and finite elements, and is distinguished by the fact that
abstract concepts are motivated and illustrated wherever possible. It is intended for use by senior undergraduates and graduates in mathematics, the physical sciences and engineering, who may not have been exposed to the conventional prerequisites for a course in functional analysis, such as real analysis. Mature researchers wishing to learn the basic ideas of functional analysis will equally find this useful. Offers a good grounding in those aspects of functional analysis which are most relevant to a proper understanding and appreciation of the mathematical aspects of boundary-value problems and the finite element method.


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Approximation of Elliptic Boundary-Value Problems - Jean-Pierre Aubin - 2007

A marriage of the finite-differences method with variational methods for solving boundary-value problems, the finite-element method is superior in many ways to finite-differences alone. This self-contained text for advanced undergraduates and graduate students is
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**Elliptic Boundary Value Problems on Corner Domains** - Monique Dauge - 2006-11-14
This research monograph focusses on a large class of variational elliptic problems with mixed boundary conditions on domains with various corner singularities, edges, polyhedral vertices, cracks, slits. In a natural functional framework (ordinary Sobolev Hilbert spaces) Fredholm and semi-Fredholm properties of induced operators are completely characterized. By specially choosing the classes of operators and domains and the functional spaces used, precise and general results may be obtained on the smoothness and asymptotics of solutions. A new type of characteristic condition is introduced which involves the spectrum of associated operator pencils and some ideals of polynomials satisfying some boundary
functional framework methods involve many perturbation arguments and a new use of Mellin transform. Basic knowledge about BVP on smooth domains in Sobolev spaces is the main prerequisite to the understanding of this book. Readers interested in the general theory of corner domains will find here a new basic theory (new approaches and results) as well as a synthesis of many already known results; those who need regularity conditions and descriptions of singularities for numerical analysis will find precise statements and also a means to obtain further one in many explicit situations.

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important classes of singularities for numerical analysis will find precise statements and also a means to obtain further one in many explicit situations.

**Singularly Perturbed Boundary-Value Problems** - Luminita Barbu - 2007-12-14
This book offers a detailed asymptotic analysis of some important classes of singularly perturbed boundary value problems which are mathematical models for phenomena in biology, chemistry, and engineering. The authors are particularly interested in nonlinear problems, which have gone little-examined so far in literature dedicated to singular perturbations. The treatment presented here combines successful results from functional analysis, singular perturbation theory, partial differential equations, and evolution equations.

**Ill-Posed Internal Boundary Value Problems for the Biharmonic Equation** - Mukarram A. Atakhodzhaev - 2014-07-24
Internal boundary value problems deals with the problem of determining the solution of an equation if data are given on two manifolds. One manifold is the domain boundary and the other manifold is situated inside the domain. This monograph studies three essentially ill-posed internal boundary value problems for the biharmonic
some variants of these problems and the Cauchy problem, as well as the m-dimensional case, are considered. The author introduces some new notions, such as the notion of complete solvability.

Operator Methods for Boundary Value Problems - Seppo Hassi - 2012-10-11
Presented in this volume are a number of new results concerning the extension theory and spectral theory of unbounded operators using the recent notions of boundary triplets and boundary relations. This approach relies on linear single-valued and multi-valued maps, isometric in a Krein space sense, and offers a basic framework for recent developments in system theory. Central to the theory are analytic tools such as Weyl functions, including Titchmarsh-Weyl m-functions and Dirichlet-to-Neumann maps. A wide range of topics is considered in this context from the abstract to the applied, including boundary value problems for ordinary
Weyl functions, including equations; infinite-dimensional perturbations; local point-interactions; boundary and passive control state/signal systems; extension theory of accretive, sectorial and symmetric operators; and Calkin's abstract boundary conditions. This accessible treatment of recent developments, written by leading researchers, will appeal to a broad range of researchers, students and professionals.

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**Lectures on Elliptic Boundary Value Problems** - Shmuel Agmon - 2010-02-03
This book, which is a new edition of a book originally published in 1965, presents an introduction to the theory of higher-order elliptic boundary value problems. The book contains a detailed study of basic problems of the
existence and regularity of solutions of higher-order elliptic boundary value problems. It also contains a study of spectral properties of operators associated with elliptic boundary value problems. Weyl's law on the asymptotic distribution of eigenvalues is studied in great generality.

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**Analysis as a Tool in Mathematical Physics** - Pavel Kurasov - 2020-07-14
Boris Pavlov (1936-2016), to whom this volume is dedicated, was a prominent specialist in analysis, operator theory, and mathematical physics. As one of the most influential members of the St. Petersburg Mathematical School, he was one of the founders of the Leningrad School of Non-self-adjoint Operators. This volume collects research papers originating from two conferences that were organized in memory of Boris Pavlov: “Spectral Theory and Applications”, held in Stockholm, Sweden, in March 2016, and “Operator Theory, Analysis and Mathematical Physics - OTAMP2016” held at the Euler Institute in St. Petersburg, Russia, in August 2016. The volume also includes water-color paintings by Boris Pavlov, some personal photographs, as well as tributes from friends and colleagues.

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**Nonlinear Boundary Value Problems in Hilbert Spaces**
- J.W. Lee - 1988

**Polyharmonic Boundary Value Problems** - Filippo Gazzola - 2010-05-26
This accessible monograph covers higher order linear and nonlinear elliptic boundary value problems in bounded domains, mainly with the biharmonic or poly-harmonic operator as leading principal part. It provides rapid access to recent results and references.

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**Integral Equations And Boundary Value Problems - Proceedings Of The**
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Guo Chun Wen - 1991-03-15
The proceedings covers the following topics: Boundary value problems of partial differential equations including free boundary problems; Theory and methods of integral equations including singular integral equations; Applications of integral equations and boundary value problems to mechanics and physics; and numerical methods for integral equations and boundary value problems.

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The objectives of this monograph are to present some topics from the theory of monotone operators and nonlinear semigroup theory which are directly applicable to the existence and uniqueness theory of initial-boundary-value problems for partial differential equations and to construct such operators as realizations of those problems in appropriate function spaces. A highlight of this presentation is the large number and variety of examples introduced to illustrate the connection between the theory of nonlinear operators and partial differential equations. These include primarily semilinear or quasilinear equations of elliptic or of parabolic type, degenerate cases with change of type, related systems and variational inequalities, and
which are directly applicable to the usual Dirichlet, Neumann, Robin or dynamic type. The discussions of evolution equations include the usual initial-value problems as well as periodic or more general nonlocal constraints, history-value problems, those which may change type due to a possibly vanishing coefficient of the time derivative, and other implicit evolution equations or systems including hysteresis models. The scalar conservation law and semilinear wave equations are briefly mentioned, and hyperbolic systems arising from vibrations of elastic-plastic rods are developed. The origins of a representative sample of such problems are given in the appendix.


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**Solvability of Nonlinear Equations and Boundary Value Problems** - Svatopluk Fucik - 1981-02-28

**Boundary Value Problems of Mathematical Physics. IX** - Olga Alexandrovna Ladyzhenskaya - 1977

**Theory of Singular Boundary Value Problems** - Donal O'Regan - 1994

in the rapidly developing areas of regular and singular boundary value problems. It also provides a detailed account of the current state of the literature on existence theory for ordinary differential equations. Results are presented for finite and semi-infinite intervals. Singularities in both independent and dependent variables are discussed.

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**Boundary Value Problems** - Frank Spitzer - 1984
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**Strongly Irreducible Operators on Hilbert Space**
- Chun Lan Jiang - 1998-05-01
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