

GRADUATE STUDIES
IN MATHEMATICS **112**

**Optimal Control
of Partial Differential
Equations**

Theory, Methods and
Applications

Fredi Tröltzsch



AMERICAN
MATHEMATICAL
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Optimal Control Of Partial Differential

Karl-Heinz Hoffmann, Werner Krabs



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Optimal Control of Partial Differential Equations Fredi Tröltzsch, 2024-03-21 Optimal control theory is concerned with finding control functions that minimize cost functions for systems described by differential equations. The methods have found widespread applications in aeronautics, mechanical engineering, the life sciences, and many other disciplines. This book focuses on optimal control problems where the state equation is an elliptic or parabolic partial differential equation. Included are topics such as the existence of optimal solutions, necessary optimality conditions, and adjoint equations, second order sufficient conditions, and main principles of selected numerical techniques. It also contains a survey on the Karush-Kuhn-Tucker theory of nonlinear programming in Banach spaces. The exposition begins with control problems with linear equations, quadratic cost functions, and control constraints. To make the book self-contained, basic facts on weak solutions of elliptic and parabolic equations are introduced. Principles of functional analysis are introduced and explained as they are needed. Many simple examples illustrate the theory and its hidden difficulties. This start to the book makes it fairly self-contained and suitable for advanced undergraduates or beginning graduate students. Advanced control problems for nonlinear partial differential equations are also discussed. As prerequisites, results on boundedness and continuity of solutions to semilinear elliptic and parabolic equations are addressed. These topics are not yet readily available in books on PDEs, making the exposition also interesting for researchers. Alongside the main theme of the analysis of problems of optimal control, Tröltzsch also discusses numerical techniques. The exposition is confined to brief introductions into the basic ideas in order to give the reader an impression of how the theory can be realized numerically. After reading this book, the reader will be familiar with the main principles of the numerical analysis of PDE constrained optimization.

Optimal Control of Partial Differential Equations Involving Pointwise State Constraints: Regularization and Applications Irwin Yousept, 2008

Optimal Control of Partial Differential Equations Karl-Heinz Hoffmann, Werner Krabs, 1984

Optimal Control of Partial Differential Equations ; 1, 1984

Optimal Control of PDEs under Uncertainty Jesús Martínez-Frutos, Francisco Periago Esparza, 2018-08-30 This book provides a direct and comprehensive introduction to theoretical and numerical concepts in the emerging field of optimal control of partial differential equations (PDEs) under uncertainty. The main objective of the book is to offer graduate students and researchers a smooth transition from optimal control of deterministic PDEs to optimal control of random PDEs. Coverage includes uncertainty modelling in control problems, variational formulation of PDEs with random inputs, robust and risk averse formulations of optimal control problems, existence theory, and numerical resolution methods. The exposition focusses on the entire path starting from uncertainty modelling and ending in the practical implementation of numerical schemes for the numerical approximation of the considered problems. To this end, a selected number of illustrative examples are analysed in detail throughout the book. Computer codes written in MatLab are provided for all these examples. This book is addressed to graduate students and researchers in Engineering, Physics, and Mathematics who are interested in

optimal control and optimal design for random partial differential equations *Optimal Control of Partial Differential Equations II: Theory and Applications* Karl Heinrich Hofmann, 1987 *Constrained Optimization and Optimal Control for Partial Differential Equations* Günter Leugering, Sebastian Engell, Andreas Griewank, Michael Hinze, Rolf Rannacher, Volker Schulz, Michael Ulbrich, Stefan Ulbrich, 2012-01-03 This special volume focuses on optimization and control of processes governed by partial differential equations The contributors are mostly participants of the DFG priority program 1253 Optimization with PDE constraints which is active since 2006 The book is organized in sections which cover almost the entire spectrum of modern research in this emerging field Indeed even though the field of optimal control and optimization for PDE constrained problems has undergone a dramatic increase of interest during the last four decades a full theory for nonlinear problems is still lacking The contributions of this volume some of which have the character of survey articles therefore aim at creating and developing further new ideas for optimization control and corresponding numerical simulations of systems of possibly coupled nonlinear partial differential equations The research conducted within this unique network of groups in more than fifteen German universities focuses on novel methods of optimization control and identification for problems in infinite dimensional spaces shape and topology problems model reduction and adaptivity discretization concepts and important applications Besides the theoretical interest the most prominent question is about the effectiveness of model based numerical optimization methods for PDEs versus a black box approach that uses existing codes often heuristic based for optimization **Optimal Control Problems for Partial Differential Equations on Reticulated Domains** Peter I. Kogut, Günter R. Leugering, 2011-09-09 In the development of optimal control the complexity of the systems to which it is applied has increased significantly becoming an issue in scientific computing In order to carry out model reduction on these systems the authors of this work have developed a method based on asymptotic analysis Moving from abstract explanations to examples and applications with a focus on structural network problems they aim at combining techniques of homogenization and approximation *Optimal Control Problems for Partial Differential Equations on Reticulated Domains* is an excellent reference tool for graduate students researchers and practitioners in mathematics and areas of engineering involving reticulated domains Optimization, Optimal Control and Partial Differential Equations V. Barbu, J.F. Bonnans, D. Tiba, 2013-03-07 This book collects research papers presented in the First Franco Romanian Conference on Optimization Optimal Control and Partial Differential Equations held at Iasi on 7-11 September 1992 The aim and the underlying idea of this conference was to take advantage of the new social developments in East Europe and in particular in Romania to stimulate the scientific contacts and cooperation between French and Romanian mathematicians and teams working in the field of optimization and partial differential equations This volume covers a large spectrum of problems and result developments in this field in which most of the participants have brought notable contributions The following topics are discussed in the contributions presented in this volume 1 Variational methods in mechanics and physical models Here we

mention the contributions of D Cioranescu P Donato and H I Ene fluid flows in dielectric porous media R Stavre the impact of a jet with two fluids on a porous wall C Lefter and D Motreanu nonlinear eigenvalue problems with discontinuities I Rus maximum principles for elliptic systems and on asymptotic XII properties of solutions of evolution equations R Latcu and M Megan R Luca and R Morozanu R Faure 2 The controllability of Infinite dimensional and distributed parameter systems with the contribution of P Grisvard singularities and exact controllability for hyperbolic systems G Geymonat P Loreti and V Valente exact controllability of a shallow shell model C

Optimal Control and Partial Differential Equations José Luis Menaldi,Edmundo Rofman,Agnes Sulem,2001 This volume contains more than sixty invited papers of international wellknown scientists in the fields where Alain Bensoussan's contributions have been particularly important filtering and control of stochastic systems variational problems applications to economy and finance numerical analysis In particular the extended texts of the lectures of Professors Jens Frehse Hitashi Ishii Jacques Louis Lions Sanjoy Mitter Umberto Mosco Bernt Oksendal George Papanicolaou A Shiryaev given in the Conference held in Paris on December 4th 2000 in honor of Professor Alain Bensoussan are included

Optimal Control of Partial Differential Equations Karl-Heinz Hoffmann,Werner Krabs,1991

Optimal Control of Partial Differential Equations Andrea Manzoni,Alfio Quarteroni,Sandro Salsa,2022-01-01 This is a book on optimal control problems OCPs for partial differential equations PDEs that evolved from a series of courses taught by the authors in the last few years at Politecnico di Milano both at the undergraduate and graduate levels The book covers the whole range spanning from the setup and the rigorous theoretical analysis of OCPs the derivation of the system of optimality conditions the proposition of suitable numerical methods their formulation their analysis including their application to a broad set of problems of practical relevance The first introductory chapter addresses a handful of representative OCPs and presents an overview of the associated mathematical issues The rest of the book is organized into three parts part I provides preliminary concepts of OCPs for algebraic and dynamical systems part II addresses OCPs involving linear PDEs mostly elliptic and parabolic type and quadratic cost functions part III deals with more general classes of OCPs that stand behind the advanced applications mentioned above Starting from simple problems that allow a hands on treatment the reader is progressively led to a general framework suitable to face a broader class of problems Moreover the inclusion of many pseudocodes allows the reader to easily implement the algorithms illustrated throughout the text The three parts of the book are suitable to readers with variable mathematical backgrounds from advanced undergraduate to Ph D levels and beyond We believe that applied mathematicians computational scientists and engineers may find this book useful for a constructive approach toward the solution of OCPs in the context of complex applications

Domain in Decomposition Methods in Optimal Control of Partial Differential Equations John E. Lagnese,Günter Leugering,2004-09-27 While domain decomposition methods have a long history dating back well over one hundred years it is only during the last decade that they have become a major tool in numerical analysis of partial differential equations This

monograph emphasizes domain decomposition methods in the context of so called virtual optimal control problems and treats optimal control problems for partial differential equations and their decompositions using an all at once approach

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Tröltzsch, 2012-12-06 The application of PDE based control theory and the corresponding numerical algorithms to industrial problems have become increasingly important in recent years This volume offers a wide spectrum of aspects of the discipline and is of interest to mathematicians and scientists working in the field Optimal Control of Systems Governed by Partial

Differential Equations Jacques-Louis Lions, 1971 **Optimal Control of Partial Differential Equations ; 2**, 1987

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Control of Partial Differential Equations Karl-Heinz Hoffmann, Werner Krabs, 2014-01-15 The application of PDE based control theory and the corresponding numerical algorithms to industrial problems have become increasingly important in recent years This volume offers a wide spectrum of aspects of the discipline and is of interest to mathematicians and scientists working in the field *Optimal Control of Partial Differential Equations II: Theory and Applications* K.-H.

Hoffmann, W. Krabs, 2013-03-14 This volume contains the contributions of participants of the conference Optimal Control of Partial Differential Equations which under the chairmanship of the editors took place at the Mathematisches Forschungsinstitut Oberwolfach from May 18 to May 24 1986 The great variety of topics covered by the contributions strongly indicates that also in the future it will be impossible to develop a unifying control theory of partial differential equations On the other hand there is a strong tendency to treat problems which are directly connected to practical applications So this volume contains real world applications like optimal cooling laws for the production of rolled steel or concrete solutions for the problem of optimal shape design in mechanics and hydrodynamics Another main topic is the construction of numerical methods This includes applications of the finite element method as well as of Quasi Newton methods to constrained and unconstrained control problems Also very complex problems arising in the theory of free boundary value problems are treated Inally some contributions show how practical problems stimulate the further development of the theory in particular this is the case for fields like suboptimal control necessary optimality conditions and sensitivity analysis As usual the lectures and stimulating discussions took place in the pleasant atmosphere of the Mathematisches Forschungsinstitut Oberwolfach Special thanks of the participants are returned to the Director as well as to the staff of the institute

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