

**Systems
& Control:
Foundations
& Applications**

**Xunjing Li
Jiongmin Yong**

Optimal Control Theory for Infinite Dimensional Systems

Birkhäuser

Optimal Control Theory For Infinite Dimensional Systems Systems Control Foundations Applications

Hector O. Fattorini



Optimal Control Theory For Infinite Dimensional Systems Systems Control Foundations Applications:

Optimal Control Theory for Infinite Dimensional Systems Xungjing Li, Jiongmin Yong, 2012-12-06 Infinite dimensional systems can be used to describe many phenomena in the real world As is well known heat conduction properties of elastic plastic material fluid dynamics diffusion reaction processes etc all lie within this area The object that we are studying temperature displacement concentration velocity etc is usually referred to as the state We are interested in the case where the state satisfies proper differential equations that are derived from certain physical laws such as Newton's law Fourier's law etc The space in which the state exists is called the state space and the equation that the state satisfies is called the state equation By an infinite dimensional system we mean one whose corresponding state space is infinite dimensional In particular we are interested in the case where the state equation is one of the following types partial differential equation functional differential equation integro differential equation or abstract evolution equation The case in which the state equation is being a stochastic differential equation is also an infinite dimensional problem but we will not discuss such a case in this book Infinite Dimensional Optimization and Control Theory Hector O. Fattorini, 1999-03-28 Treats optimal problems for systems described by ODEs and PDEs using an approach that unifies finite and infinite dimensional nonlinear programming **Control in Finite and Infinite Dimension** Emmanuel Trélat, 2024-09-05 This book is the result of various master and summer school courses the author has taught The objective is to provide the reader with an introduction to control theory and to the main tools allowing to treat general control systems The author hopes this book will serve as motivation to go deeper into the theory or numerical aspects that are not covered in this book This book might be helpful for graduate students and researchers in the field of control theory **Optimal Control Theory** Suresh P. Sethi, 2022-01-03 This new 4th edition offers an introduction to optimal control theory and its diverse applications in management science and economics It introduces students to the concept of the maximum principle in continuous as well as discrete time by combining dynamic programming and Kuhn Tucker theory While some mathematical background is needed the emphasis of the book is not on mathematical rigor but on modeling realistic situations encountered in business and economics It applies optimal control theory to the functional areas of management including finance production and marketing as well as the economics of growth and of natural resources In addition it features material on stochastic Nash and Stackelberg differential games and an adverse selection model in the principal agent framework Exercises are included in each chapter while the answers to selected exercises help deepen readers understanding of the material covered Also included are appendices of supplementary material on the solution of differential equations the calculus of variations and its ties to the maximum principle and special topics including the Kalman filter certainty equivalence singular control a global saddle point theorem Sethi Skiba points and distributed parameter systems Optimal control methods are used to determine optimal ways to control a dynamic system The theoretical work in this field serves as the foundation for the book in which the author applies it to

business management problems developed from his own research and classroom instruction The new edition has been refined and updated making it a valuable resource for graduate courses on applied optimal control theory but also for financial and industrial engineers economists and operational researchers interested in applying dynamic optimization in their fields

Stochastic Optimal Control in Infinite Dimension Giorgio Fabbri, Fausto Gozzi, Andrzej Święch, 2017-06-22 Providing an introduction to stochastic optimal control in infinite dimension this book gives a complete account of the theory of second order HJB equations in infinite dimensional Hilbert spaces focusing on its applicability to associated stochastic optimal control problems It features a general introduction to optimal stochastic control including basic results e g the dynamic programming principle with proofs and provides examples of applications A complete and up to date exposition of the existing theory of viscosity solutions and regular solutions of second order HJB equations in Hilbert spaces is given together with an extensive survey of other methods with a full bibliography In particular Chapter 6 written by M Fuhrman and G Tessitore surveys the theory of regular solutions of HJB equations arising in infinite dimensional stochastic control via BSDEs The book is of interest to both pure and applied researchers working in the control theory of stochastic PDEs and in PDEs in infinite dimension Readers from other fields who want to learn the basic theory will also find it useful The prerequisites are standard functional analysis the theory of semigroups of operators and its use in the study of PDEs some knowledge of the dynamic programming approach to stochastic optimal control problems in finite dimension and the basics of stochastic analysis and stochastic equations in infinite dimensional spaces

Introduction to Infinite-Dimensional Systems Theory Ruth Curtain, Hans Zwart, 2020-04-05 Infinite dimensional systems is a well established area of research with an ever increasing number of applications Given this trend there is a need for an introductory text treating system and control theory for this class of systems in detail This textbook is suitable for courses focusing on the various aspects of infinite dimensional state space theory This book is made accessible for mathematicians and post graduate engineers with a minimal background in infinite dimensional system theory To this end all the system theoretic concepts introduced throughout the text are illustrated by the same types of examples namely diffusion equations wave and beam equations delay equations and the new class of platoon type systems Other commonly met distributed and delay systems can be found in the exercise sections Every chapter ends with such a section containing about 30 exercises testing the theoretical concepts as well An extensive account of the mathematical background assumed is contained in the appendix

An Introduction to Optimal Control Theory Onésimo Hernández-Lerma, Leonardo R. Laura-Guarachi, Saul Mendoza-Palacios, David González-Sánchez, 2023-02-21 This book introduces optimal control problems for large families of deterministic and stochastic systems with discrete or continuous time parameter These families include most of the systems studied in many disciplines including Economics Engineering Operations Research and Management Science among many others The main objective is to give a concise systematic and reasonably self contained presentation of some key topics in optimal control

theory To this end most of the analyses are based on the dynamic programming DP technique This technique is applicable to almost all control problems that appear in theory and applications They include for instance finite and infinite horizon control problems in which the underlying dynamic system follows either a deterministic or stochastic difference or differential equation In the infinite horizon case it also uses DP to study undiscounted problems such as the ergodic or long run average cost After a general introduction to control problems the book covers the topic dividing into four parts with different dynamical systems control of discrete time deterministic systems discrete time stochastic systems ordinary differential equations and finally a general continuous time MCP with applications for stochastic differential equations The first and second part should be accessible to undergraduate students with some knowledge of elementary calculus linear algebra and some concepts from probability theory random variables expectations and so forth Whereas the third and fourth part would be appropriate for advanced undergraduates or graduate students who have a working knowledge of mathematical analysis derivatives integrals and stochastic processes

Time Optimal Control of Evolution Equations Gengsheng Wang, Lijuan Wang, Yashan Xu, Yubiao Zhang, 2018-08-22 This monograph develops a framework for time optimal control problems focusing on minimal and maximal time optimal controls for linear controlled evolution equations Its use in optimal control provides a welcome update to Fattorini's work on time optimal and norm optimal control problems By discussing the best way of representing various control problems and equivalence among them this systematic study gives readers the tools they need to solve practical problems in control After introducing preliminaries in functional analysis evolution equations and controllability and observability estimates the authors present their time optimal control framework which consists of four elements a controlled system a control constraint set a starting set and an ending set From there they use their framework to address areas of recent development in time optimal control including the existence of admissible controls and optimal controls Pontryagin's maximum principle for optimal controls the equivalence of different optimal control problems and bang bang properties This monograph will appeal to researchers and graduate students in time optimal control theory as well as related areas of controllability and dynamic programming For ease of reference the text itself is self contained on the topic of time optimal control Frequent examples throughout clarify the applications of theorems and definitions although experience with functional analysis and differential equations will be useful

Control Theory and Related Topics Shanjian Tang, Jiongmin Yong, 2007 Professor Xunjing Li 1935-2003 was a pioneer in control theory in China He was influential in the Chinese community of applied mathematics and the global community of optimal control theory of distributed parameter systems He has made very important contributions to the optimal control theory of distributed parameter systems in particular regarding the first order necessary conditions Pontryagin type maximum principle for optimal control of nonlinear infinite dimensional systems This proceedings volume is a collection of original research papers or reviews authored or co authored by Professor Li's former students postdoctoral fellows and mentored scholars in the areas of control theory dynamic

systems mathematical finance and stochastic analysis among others These articles show in some degree the influence of Professor Xunjing Li

Statistical Methods and Applications in Insurance and Finance M'hamed Eddahbi, El Hassan Essaky, Josep Vives, 2016-04-08 This book is the outcome of the CIMPA School on Statistical Methods and Applications in Insurance and Finance held in Marrakech and Kelaat M gouna Morocco in April 2013 It presents two lectures and seven refereed papers from the school offering the reader important insights into key topics The first of the lectures by Frederic Viens addresses risk management via hedging in discrete and continuous time while the second by Boualem Djehiche reviews statistical estimation methods applied to life and disability insurance The refereed papers offer diverse perspectives and extensive discussions on subjects including optimal control financial modeling using stochastic differential equations pricing and hedging of financial derivatives and sensitivity analysis Each chapter of the volume includes a comprehensive bibliography to promote further research

Mathematical Control Theory for Stochastic Partial Differential Equations Qi Lü, Xu Zhang, 2021-09-17 This is the first book to systematically present control theory for stochastic distributed parameter systems a comparatively new branch of mathematical control theory The new phenomena and difficulties arising in the study of controllability and optimal control problems for this type of system are explained in detail Interestingly enough one has to develop new mathematical tools to solve some problems in this field such as the global Carleman estimate for stochastic partial differential equations and the stochastic transposition method for backward stochastic evolution equations In a certain sense the stochastic distributed parameter control system is the most general control system in the context of classical physics Accordingly studying this field may also yield valuable insights into quantum control systems A basic grasp of functional analysis partial differential equations and control theory for deterministic systems is the only prerequisite for reading this book

Control Theory And Related Topics: In Memory Of Professor Xunjing Li Shanjian Tang, Jiongmin Yong, 2007-09-27 Xunjing Li 1935 2003 was a pioneer in control theory in China He was known in the Chinese community of applied mathematics and in the global community of optimal control theory of distributed parameter systems He has made important contributions to the optimal control theory of distributed parameter systems in particular regarding the first order necessary conditions Pontryagin type maximum principle for optimal control of nonlinear infinite dimensional systems He directed the Seminar of Control Theory at Fudan towards stochastic control theory in 1980s and mathematical finance in 1990s which has led to several important subsequent developments in both closely interactive fields These remarkable efforts in scientific research and education among others gave birth to the so called Fudan School This proceedings volume includes a collection of original research papers or reviews authored or co authored by Xunjing Li s former students postdoctoral fellows and mentored scholars in the areas of control theory dynamic systems mathematical finance and stochastic analysis among others

Numerical Control: Part B Emmanuel Trélat, Enrique Zuazua, 2023-02-20 Numerical Control Part B Volume 24 in the Handbook of Numerical Analysis series highlights new advances in the field with

this new volume presenting interesting chapters written by an international board of authors Chapters in this volume include Control problems in the coefficients and the domain for linear elliptic equations Computational approaches for extremal geometric eigenvalue problems Non overlapping domain decomposition in space and time for PDE constrained optimal control problems on networks Feedback Control of Time dependent Nonlinear PDEs with Applications in Fluid Dynamics Stabilization of the Navier Stokes equations Theoretical and numerical aspects Reconstruction algorithms based on Carleman estimates and more Other sections cover Discrete time formulations as time discretization strategies in data assimilation Back and forth iterations Time reversal methods Unbalanced Optimal Transport from Theory to Numerics An ADMM Approach to the Exact and Approximate Controllability of Parabolic Equations Nonlocal balance laws an overview over recent results Numerics and control of conservation laws Numerical approaches for simulation and control of superconducting quantum circuits and much more Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Handbook of Numerical Analysis series Updated release includes the latest information on Numerical Control Periodic Feedback Stabilization for Linear Periodic Evolution Equations Gengsheng Wang,Yashan Xu,2017-02-08 This book introduces a number of recent advances regarding periodic feedback stabilization for linear and time periodic evolution equations First it presents selected connections between linear quadratic optimal control theory and feedback stabilization theory for linear periodic evolution equations Secondly it identifies several criteria for the periodic feedback stabilization from the perspective of geometry algebra and analyses respectively Next it describes several ways to design periodic feedback laws Lastly the book introduces readers to key methods for designing the control machines Given its coverage and scope it offers a helpful guide for graduate students and researchers in the areas of control theory and applied mathematics **Maximum Principle and Dynamic Programming Viscosity Solution Approach** Bing Sun,Bao-Zhu Guo,Zhen-Zhen Tao,2025-08-02 This book is concerned with optimal control problems of dynamical systems described by partial differential equations PDEs The content covers the theory and numerical algorithms starting with open loop control and ending with closed loop control It includes Pontryagin s maximum principle and the Bellman dynamic programming principle based on the notion of viscosity solution The Bellman dynamic programming method can produce the optimal control in feedback form making it more appealing for online implementations and robustness The determination of the optimal feedback control law is of fundamental importance in optimal control and can be argued as the Holy Grail of control theory The book is organized into five chapters Chapter 1 presents necessary mathematical knowledge Chapters 2 and 3 Part 1 focus on the open loop control while Chapter 4 and 5 Part 2 focus on the closed loop control In this monograph we incorporate the notion of viscosity solution of PDE with dynamic programming approach The dynamic programming viscosity solution DPVS approach is then used to investigate optimal control problems In each problem the optimal feedback law is synthesized and numerically demonstrated The last chapter presents multiple algorithms for the DPVS approach

including an upwind finite difference scheme with the convergence proof It is worth noting that the dynamic systems considered are primarily of technical or biologic origin which is a highlight of the book This book is systematic and self contained It can serve the expert as a ready reference for control theory of infinite dimensional systems These chapters taken together would also make a one semester course for graduate with first courses in PDE constrained optimal control Some Problems on Nonlinear Hyperbolic Equations and Applications Yuejun Peng,Bopeng Rao,2010 This volume is composed of two parts Mathematical and Numerical Analysis for Strongly Nonlinear Plasma Models and Exact Controllability and Observability for Quasilinear Hyperbolic Systems and Applications It presents recent progress and results obtained in the domains related to both subjects without attaching much importance to the details of proofs but rather to difficulties encountered to open problems and possible ways to be exploited It will be very useful for promoting further study on some important problems in the future *General Pontryagin-Type Stochastic Maximum Principle and Backward Stochastic Evolution Equations in Infinite Dimensions* Qi Lü,Xu Zhang,2014-06-02 The classical Pontryagin maximum principle addressed to deterministic finite dimensional control systems is one of the three milestones in modern control theory The corresponding theory is by now well developed in the deterministic infinite dimensional setting and for the stochastic differential equations However very little is known about the same problem but for controlled stochastic infinite dimensional evolution equations when the diffusion term contains the control variables and the control domains are allowed to be non convex Indeed it is one of the longstanding unsolved problems in stochastic control theory to establish the Pontryagin type maximum principle for this kind of general control systems this book aims to give a solution to this problem This book will be useful for both beginners and experts who are interested in optimal control theory for stochastic evolution equations

Optimization and Control for Partial Differential Equations Roland Herzog,Matthias Heinkenschloss,Dante Kalise,Georg Stadler,Emmanuel Trélat,2022-03-07 This book highlights new developments in the wide and growing field of partial differential equations PDE constrained optimization Optimization problems where the dynamics evolve according to a system of PDEs arise in science engineering and economic applications and they can take the form of inverse problems optimal control problems or optimal design problems This book covers new theoretical computational as well as implementation aspects for PDE constrained optimization problems under uncertainty in shape optimization and in feedback control and it illustrates the new developments on representative problems from a variety of applications **Numerical Control: Part A**,2022-02-15 Numerical Control Part A Volume 23 in the Handbook of Numerical Analysis series highlights new advances in the field with this new volume presenting interesting chapters written by an international board of authors Chapters in this volume include Numerics for finite dimensional control systems Moments and convex optimization for analysis and control of nonlinear PDEs The turnpike property in optimal control Structure Preserving Numerical Schemes for Hamiltonian Dynamics Optimal Control of PDEs and FE Approximation Filtration techniques for the uniform controllability of semi discrete

hyperbolic equations Numerical controllability properties of fractional partial differential equations Optimal Control Numerics and Applications of Fractional PDEs and much more Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Handbook of Numerical Analysis series Updated release includes the latest information on Numerical Control *Partially Observable Linear Systems Under Dependent Noises* Agamirza E. Bashirov, 2003-01-23 This book discusses the methods of fighting against noise It can be regarded as a mathematical view of specific engineering problems with known and new methods of control and estimation in noisy media From the reviews An excellent reference on the complete sets of equations for the optimal controls and for the optimal filters under wide band noises and shifted white noises and their possible application to navigation of spacecraft MATHEMATICAL REVIEWS

Optimal Control Theory For Infinite Dimensional Systems Systems Control Foundations Applications Book Review: Unveiling the Magic of Language

In an electronic digital era where connections and knowledge reign supreme, the enchanting power of language has are more apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is truly remarkable. This extraordinary book, aptly titled "**Optimal Control Theory For Infinite Dimensional Systems Systems Control Foundations Applications**," written by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we shall delve to the book is central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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