

Optimal Control Theory With Applications In Economics

Optimal control methods are used to determine optimal ways to control a dynamic system. The theoretical work in this field serves as a foundation for the book, which the authors have applied to business management problems developed from their research and classroom instruction. Sethi and Thompson have provided management science and economics communities with a thoroughly revised edition of their classic text on Optimal Control Theory. The new edition has been completely refined with careful attention to the text and graphic material presentation. Chapters cover a range of topics including finance, production and inventory problems, marketing problems, machine maintenance and replacement, problems of optimal consumption of natural resources, and applications of control theory to economics. The book contains new results that were not available when the first edition was published, as well as an expansion of the material on stochastic optimal control theory.

A rigorous introduction to optimal control theory, which will enable engineers and scientists to put the theory into practice.

Foundations of Dynamic Economic Analysis presents a modern and thorough exposition of the fundamental mathematical formalism used to study optimal control theory, i.e., continuous time dynamic economic processes, and to interpret dynamic economic behavior. The style of presentation, with its continual emphasis on the economic interpretation of mathematics and models, distinguishes it from several other excellent texts on the subject. This approach is aided dramatically by introducing the dynamic envelope theorem and the method of comparative dynamics early in the exposition. Accordingly, motivated and economically revealing proofs of the transversality conditions come about by use of the dynamic envelope theorem. Furthermore, such sequencing of the material naturally leads to the development of the primal-dual method of comparative dynamics and dynamic duality theory, two modern approaches used to tease out the empirical content of optimal control models. The stylistic approach ultimately draws attention to the empirical richness of optimal control theory, a feature missing in virtually all other textbooks of this type.

This volume gives the latest advances in optimization and optimal control which are the main part of applied mathematics. It covers various topics of optimization, optimal control and operations research.

Optimal Control of Partial Differential Equations

A Primer on the Calculus of Variations and Optimal Control Theory

Applications to Management Science and Economics

Optimization and Optimal Control

Applied and Computational Optimal Control

From economics and business to the biological sciences to physics and engineering, professionals successfully use the powerful mathematical tool of optimal control to make management and strategy decisions. Optimal Control Applied to Biological Models thoroughly develops the mathematical aspects of optimal control theory and provides insight into the application of this theory to biological models. Focusing on mathematical concepts, the book first examines the most basic problem for continuous time ordinary differential equations (ODEs) before discussing more complicated problems, such as variations of the initial conditions, imposed bounds on the control, multiple states and controls, linear dependence on the control, and free terminal time. In addition, the authors introduce the optimal control of discrete systems and of partial differential equations (PDEs). Featuring a user-friendly interface, the book contains fourteen interactive sections of various applications, including immunology and epidemic disease models, management decisions in harvesting, and resource allocation models. It also develops the underlying numerical methods of the applications and includes the MATLAB® codes on which the applications are based. Requiring only basic knowledge of multivariable calculus, simple ODEs, and mathematical models, this text shows how to adjust controls in biological systems in order to achieve proper outcomes.

The calculus of variations is used to find functions that optimize quantities expressed in terms of integrals. Optimal control theory seeks to find functions that minimize cost integrals for systems described by differential equations. This book is an introduction to both the classical theory of the calculus of variations and the more modern developments of optimal control theory from the perspective of an applied mathematician. It focuses on understanding concepts and how to apply them. The range of potential applications is broad: the calculus of variations and optimal control theory have been widely used in numerous ways in biology, criminology, economics, engineering, finance, management science, and physics. Applications described in this book include cancer chemotherapy, navigational control, and renewable resource harvesting. The prerequisites for the book are modest: the standard calculus sequence, a first course on ordinary differential equations, and some facility with the use of mathematical software. It is suitable for an undergraduate or beginning graduate course, or for self study. It provides excellent preparation for more advanced books and courses on the calculus of variations and optimal control theory.

Geared toward advanced undergraduate and graduate engineering students, this text introduces the theory and applications of optimal control. It serves as a bridge to the technical literature, enabling students to evaluate the implications of theoretical control work, and to judge the merits of papers on the subject. Rather than presenting an exhaustive treatise, Optimal Control offers a detailed introduction that fosters careful thinking and disciplined intuition. It develops the basic mathematical background, with a coherent formulation of the control problem and discussions of the necessary conditions for optimality based on the maximum principle of Pontryagin. In-depth examinations cover applications of the theory to minimum time, minimum fuel, and to quadratic criteria problems. The structure, properties, and engineering realizations of several optimal feedback control systems also receive attention. Special features include numerous specific problems, carried through to engineering realization in block diagram form. The text treats almost all current examples of control problems that permit analytic solutions, and its unified approach makes frequent use of geometric ideas

to encourage students' intuition.

Optimal control theory is a mathematical optimization method with important applications in the aerospace industry.

Optimal Control Theory with Aerospace Applications

An Introduction

Optimal Control, Statistics, and Path Planning

Primer on Optimal Control Theory

Optimal Control with Engineering Applications

Significant advances in the field of optimal control have been made over the past few decades. These advances have been well documented in numerous fine publications, and have motivated a number of innovations in electric power system engineering, but they have not yet been collected in book form. Our purpose in writing this book is to provide a description of some of the applications of optimal control techniques to practical power system problems. The book is designed for advanced undergraduate courses in electric power systems, as well as graduate courses in electrical engineering, applied mathematics, and industrial engineering. It is also intended as a self-study aid for practicing personnel involved in the planning and operation of electric power systems for utilities, manufacturers, and consulting and government regulatory agencies. The book consists of seven chapters. It begins with an introductory chapter that briefly reviews the history of optimal control and its power system applications and also provides an outline of the text. The second chapter is entitled "Some Optimal Control Techniques"; its intent is to introduce fundamental concepts of optimal control theory that are relevant to the applications treated in the following chapters. Emphasis is given to clear, methodical development rather than rigorous formal proofs. Topics discussed include variational calculus, Pontryagin's maximum principle, and geometric methods employing functional analysis. A number of solved examples are included to illustrate the techniques.

This book introduces a variety of problem statements in classical optimal control, in optimal estimation and filtering, and in optimal control problems with non-scalar-valued performance criteria. Many example problems are solved completely in the body of the text. All chapter-end exercises are sketched in the appendix. The theoretical part of the book is based on the calculus of variations, so the exposition is very transparent and requires little mathematical rigor.

Nonlinear Optimal Control Theory presents a deep, wide-ranging introduction to the mathematical theory of the optimal control of processes governed by ordinary differential equations and certain types of differential equations with memory. Many examples illustrate the mathematical issues that need to be addressed when using optimal control techniques in diverse areas. Drawing on classroom-tested material from Purdue University and North Carolina State University, the book gives a unified account of bounded state problems governed by ordinary, integrodifferential, and delay systems. It also discusses Hamilton-Jacobi theory. By providing a sufficient and rigorous treatment of finite dimensional control problems, the book equips readers with the foundation to deal with other types of control problems, such as those governed by stochastic differential equations, partial differential equations, and differential games.

Want to know not just what makes rockets go up but how to do it optimally? Optimal control theory has become such an important field in aerospace engineering that no graduate student or practicing engineer can afford to be without a working knowledge of it. This is the first book that begins from scratch to teach the reader the basic principles of the calculus of variations, develop the necessary conditions step-by-step, and introduce the elementary computational techniques of optimal control. This book, with problems and an online solution manual, provides the graduate-level reader with enough introductory knowledge so that he or she can not only read the literature and study the next level textbook but can also apply the theory to find optimal solutions in practice. No more is needed than the usual background of an undergraduate engineering, science, or mathematics program: namely calculus, differential equations, and numerical integration. Although finding optimal solutions for these problems is a complex process involving the calculus of variations, the authors carefully lay out step-by-step the most important theorems and concepts. Numerous examples are worked to demonstrate how to apply the theories to everything from classical problems (e.g., crossing a river in minimum time) to engineering problems (e.g., minimum-fuel launch of a satellite). Throughout the book use is made of the time-optimal launch of a satellite into orbit as an important case study with detailed analysis of two examples: launch from the Moon and launch from Earth. For launching into the field of optimal solutions, look no further!

Advances in Mathematical Modeling, Optimization and Optimal Control

Optimal Control Theory with Applications in Economics

Uncertain Optimal Control Optimal Control

A rigorous introduction to optimal control theory, with an emphasis on applications in economics. This book bridges optimal control theory and economics, discussing ordinary differential equations, optimal control, game theory, and mechanism design in one volume. Technically rigorous and largely self-contained, it provides an introduction to the use of optimal control theory for deterministic continuous-time systems in economics. The theory of ordinary differential equations (ODEs) is the backbone of the theory developed in the book, and chapter 2 offers a detailed review of basic concepts in the theory of ODEs, including the solution of systems of linear ODEs, state-space analysis, potential functions, and stability analysis. Following this, the book covers the main results of optimal control theory, in particular necessary and sufficient optimality conditions; game theory, with an emphasis on differential games; and the application of control-theoretic concepts to the design of economic mechanisms. Appendixes provide a mathematical review and solutions to all end-of-chapter problems. The material is presented at three levels: single-person decision making; games, in which a group of decision makers interact strategically; and mechanism design, which is concerned with a designer's creation of an environment in which players interact to maximize the designer's objective. The book focuses on applications; the problems are an integral part of the text. It is intended for use as a textbook or reference for graduate students, teachers, and researchers interested in applications of control theory beyond its classical use in economic growth. The book will also appeal to readers interested in a modeling approach to certain practical problems involving dynamic continuous-time models.

Optimization and optimal control are the main tools in decision making. Because of their numerous applications in various disciplines, research in these areas is accelerating at a rapid pace. "Optimization and Optimal Control: Theory and Applications" brings together the latest developments in these areas of research as well as presents applications of these results to a wide range of real-world problems. This volume can serve as a useful resource for researchers, practitioners, and advanced graduate students of mathematics and engineering working in research areas where results in optimization and optimal control can be applied.

Optimal Control Theory for Applications Springer Science & Business Media

The aim of this book is to furnish the reader with a rigorous and detailed exposition of the concept of control parametrization and time scaling transformation. It presents computational solution techniques for a special class of constrained optimal control problems as well as applications to some practical examples. The book may be considered an extension of the 1991 monograph *A Unified Computational Approach Optimal Control Problems*, by K.L. Teo, C.J. Goh, and K.H. Wong. This publication discusses the development of new theory and computational methods for solving various optimal control problems numerically and in a unified fashion. To keep the book accessible and uniform, it includes those results developed by the authors, their students, and their past and present collaborators. A brief review of methods that are not covered in this exposition, is also included. Knowledge gained from this book may inspire advancement of new techniques to solve complex problems that arise in the future. This book is intended as a reference for researchers in mathematics, engineering, and other sciences, graduate students and practitioners who apply optimal control methods in their work. It may be appropriate reading material for a graduate level seminar or as a text for a course in optimal control.

Optimal Control Applications in Electric Power Systems

Optimal Control Theory with Economic Applications

Control and Optimal Control Theories with Applications

Nonlinear Optimal Control Theory

Optimal Control with Aerospace Applications

The lectures gathered in this volume present some of the different aspects of Mathematical Control Theory. Adopting the point of view of Geometric Control Theory and of Nonlinear Control Theory, the lectures focus on some aspects of the Optimization and Control of nonlinear, not necessarily smooth, dynamical systems. Specifically, three of the five lectures discuss respectively: logic-based switching control, sliding mode control and the input to the state stability paradigm for the control and stability of nonlinear systems. The remaining two lectures are devoted to Optimal Control: one investigates the connections between Optimal Control Theory, Dynamical Systems and Differential Geometry, while the second presents a very general version, in a non-smooth context, of the Pontryagin Maximum Principle. The arguments of the whole volume are self-contained and are directed to everyone working in Control Theory. They offer a sound presentation of the methods employed in the control and optimization of nonlinear dynamical systems.

This undergraduate introduction to classical and modern control theory concentrates on fundamental concepts, and is student-friendly with minimum mathematical elaboration. It investigates manifold applications to varied and important present-day problems, e.g. economic growth, resource depletion, disease epidemics, exploited population, and rocket trajectories. Each topic is carefully explained by illustrative examples and chapter exercises, with tutorial solutions at the end of the book.

This book contains extended, in-depth presentations of the plenary talks from the 16th French-German-Polish Conference on Optimization, held in Kraków, Poland in 2013. Each chapter in this book exhibits a comprehensive look at new theoretical and/or application-oriented results in mathematical modeling, optimization, and optimal control. Students and researchers involved in image processing, partial differential inclusions, shape optimization, or optimal control theory and its applications to medical and rehabilitation technology, will find this book valuable. The first chapter by Martin Burger provides an overview of recent developments related to Bregman distances, which is an important tool in inverse problems and image processing. The chapter by Piotr Kalita studies the operator version of a first order in time partial differential inclusion and its time discretization. In the chapter by Günter Leugering, Jan Sokołowski and Antoni Łochowski, nonsmooth shape optimization problems for variational inequalities are considered. The next chapter, by Katja Mombaur is devoted to applications of optimal control and inverse optimal control in the field of medical and rehabilitation technology, in particular in human movement analysis, therapy and improvement by means of medical devices. The final chapter, by Nikolai Osmolovskii and Helmut Maurer provides a survey on no-gap second order optimality conditions in the calculus of variations and optimal control, and a discussion of their further development.

February 27 - March 1, 1997, the conference Optimal Control: Theory, Algorithms, and Applications took place at the University of Florida, hosted by the Center for Applied Optimization. The conference brought together researchers from universities, industry, and government laboratories in the United

States, Germany, Italy, France, Canada, and Sweden. There were forty-five invited talks, including seven talks by students. The conference was sponsored by the National Science Foundation and endorsed by the SIAM Activity Group on Control and Systems Theory, the Mathematical Programming Society, the International Federation for Information Processing (IFIP), and the International Association for Mathematics and Computers in Simulation (IMACS). Since its inception in the 1940s and 1950s, Optimal Control has been closely connected to industrial applications, starting with aerospace. The program for the Gainesville conference, which reflected the rich cross-disciplinary flavor of the field, included aerospace applications as well as both novel and emerging applications to superconductors, diffractive optics, nonlinear optics, structural analysis, bioreactors, corrosion detection, acoustic flow, process design in chemical engineering, hydroelectric power plants, sterilization of canned foods, robotics, and thermoelastic plates and shells. The three days of the conference were organized around the three conference themes, theory, algorithms, and applications. This book is a collection of the papers presented at the Gainesville conference. We would like to take this opportunity to thank the sponsors and participants of the conference, the authors, the referees, and the publisher for making this volume possible.

Lectures given at the C.I.M.E. Summer School held in Cetraro, Italy, June 19-29, 2004

Control Theoretic Splines

Optimal Control Applied to Biological Models

Proceedings of the Fourteenth Biennial Seminar of the Canadian Mathematical Congress University of Western Ontario, August 12 – 25, 1973

An Introduction to the Theory and Its Applications

This monograph is an introduction to optimal control theory for systems governed by vector ordinary differential equations. It is not intended as a state-of-the-art handbook for researchers. We have tried to keep two types of reader in mind: (1) mathematicians, graduate students, and advanced undergraduates in mathematics who want a concise introduction to a field which contains nontrivial interesting applications of mathematics (for example, weak convergence, convexity, and the theory of ordinary differential equations); (2) economists, applied scientists, and engineers who want to understand some of the mathematical foundations of optimal control theory. In general, we have emphasized motivation and explanation, avoiding the "definition-axiom-theorem-proof" approach. We make use of a large number of examples, especially one simple canonical example which we carry through the entire book. In proving theorems, we often just prove the simplest case, then state the more general results which can be proved. Many of the more difficult topics are discussed in the "Notes" sections at the end of chapters and several major proofs are in the Appendices. We feel that a solid understanding of basic facts is best attained by at first avoiding excessive generality. We have not tried to give an exhaustive list of references, preferring to refer the reader to existing books or papers with extensive bibliographies. References are given by author's name and the year of publication, e.g., Waltman [1974].

This book is devoted to the development of optimal control theory for finite dimensional systems governed by deterministic and stochastic differential equations driven by vector measures. The book deals with a broad class of controls, including regular controls (vector-valued measurable functions), relaxed controls (measure-valued functions) and controls determined by vector measures, where both fully and partially observed control problems are considered. In the past few decades, there have been remarkable advances in the field of systems and control theory thanks to the unprecedented interaction between mathematics and the physical and engineering sciences. Recently, optimal control theory for dynamic systems driven by vector measures has attracted increasing interest. This book presents this theory for dynamic systems governed by both ordinary and stochastic differential equations, including extensive results on the existence of optimal controls and necessary conditions for optimality. Computational algorithms are developed based on the optimality conditions, with numerical results presented to demonstrate the applicability of the theoretical results developed in the book. This book will be of interest to researchers in optimal control or applied functional analysis interested in applications of vector measures to control theory, stochastic systems driven by vector measures, and related topics. In particular, this self-contained account can be a starting point for further advances in the theory and applications of dynamic systems driven and controlled by vector measures.

This work (in two parts), Lecture Notes in Economics and Mathematical Systems, Volume 105 and 106, constitutes the Proceedings of the Fourteenth Biennial Seminar of the Canadian Mathematical Congress, which was held from August 12 to August 25, 1973 at the University of Western Ontario, London, Ontario. The Canadian Mathematical Congress has held Biennial Seminars since 19~7, and these have covered a wide range of topics. The Seminar reported in this publication was concerned with "Optimal Control Theory and its Applications", a subject chosen for its active ~rowth and its wide implications for other fields. Both these aspects are exemplified in these Proceedings. Some lectures provided excellent surveys of particular fields whereas others concentrated on the presentation of new results. There were six distinguished Principal Lecturers: H.T. Banks, A.R. Dobell, H. Halkin, J.L. Lions, R.M. Thrall and W.M. Wonham, all of whom gave five to ten lectures during the two weeks of the Seminar. Except for Dr. Dobell's, these will all be found in Volume 105. Besides the Principal Lecturers there were three Guest Lecturers: M.C. Delfour, V. Jurdjevic and S.P. Sethi, who presented substantial bodies of material in two or three lectures and which are included in Volume 106. Many of the participants also spoke and reports of ~0st of these have also been included (Volume 106). This book is an introduction to the mathematical theory of optimal control of processes governed by ordinary differential eq- tions. It is intended for students and professionals in mathematics and in areas of application who want a broad, yet relatively deep, concise and coherent introduction to the subject and to its relati- ship with applications. In order to accommodate a range of mathema- cal interests and backgrounds among readers, the material is arranged so that the more advanced mathematical sections can be omitted wi- out loss of continuity. For readers primarily interested in appli- tions a recommended minimum course consists of Chapter I, the sections of Chapters II, III, and IV so recommended in the introductory sec tions of those chapters, and all of Chapter V. The introductory sec tion of each chapter should further guide the individual reader toward material that is of interest to him. A reader who has had a good course in advanced calculus should be able to understand the defini tions and statements of the theorems and should be able to follow a substantial portion of the mathematical development. The entire book can be read by someone familiar with the basic aspects of Lebesgue integration and functional analysis. For the reader who wishes to find out more about applications we recommend references [2], [13], [33], [35], and [50], of the Bibliography at the end of the book.

Optimal Control Theory and Applications

Introduction to Optimal Control Theory

Optimization And Optimal Control

Calculus of Variations and Optimal Control Theory

An Introduction to the Theory with Applications

This book introduces the theory and applications of uncertain optimal control, and establishes two types of models in

expected value uncertain optimal control and optimistic value uncertain optimal control. These models, which have continuous-time forms and discrete-time forms, make use of dynamic programming. The uncertain optimal control theory relates to equations of optimality, uncertain bang-bang optimal control, optimal control with switched uncertain systems, optimal control for uncertain system with time-delay. Uncertain optimal control has applications in portfolio selection, engineering, and games. The book is a useful resource for researchers, engineers, and students in the fields of mathematics, cybernetics, operations research, industrial engineering, artificial intelligence, economics, and management science. This textbook is a straightforward introduction to the theory of optimal control with an emphasis on presenting many different applications. Professor Hocking has taken pains to ensure that the theory is developed to display the main ideas of the arguments but without using sophisticated mathematical tools. Throughout there are many worked examples, and numerous exercises (with solutions) are provided.

This book serves not only as an introduction, but also as an advanced text and reference source in the field of deterministic optimal control systems governed by ordinary differential equations. It also includes an introduction to the classical calculus of variations. An important feature of the book is the inclusion of a large number of examples, in which the theory is applied to a wide variety of economics problems. The presentation of simple models helps illuminate pertinent qualitative and analytic points, useful when confronted with a more complex reality. These models cover: economic growth in both open and closed economies, exploitation of (non-) renewable resources, pollution control, behaviour of firms, and differential games. A great emphasis on precision pervades the book, setting it apart from the bulk of literature in this area. The rigorous techniques presented should help the reader avoid errors which often recur in the application of control theory with economics.

The theory of optimal control systems has grown and flourished since the 1960's. Many texts, written on varying levels of sophistication, have been published on the subject. Yet even those purportedly designed for beginners in the field are often riddled with complex theorems, and many treatments fail to include topics that are essential to a thorough grounding in various aspects of and approaches to optimal control. Optimal Control Systems provides a comprehensive but accessible treatment of the subject with just the right degree of mathematical rigor to be complete but practical. It provides a bridge between "traditional" optimization using the calculus of variations and what is called "modern" optimal control theory. It also treats both continuous-time and discrete-time optimal control systems, giving students a firm grasp on both methods. Among this book's most outstanding features is a summary table that accompanies each topic or problem and includes a statement of the problem with a step-by-step solution. Students will also gain valuable experience in using industry-standard MATLAB and SIMULINK software, including the Control System and Symbolic Math Toolboxes. Diverse applications across fields from power engineering to medicine make a foundation in optimal control systems an essential part of an engineer's background. This clear, streamlined presentation is ideal for a graduate level course on control systems and a quick reference for working engineers.

Applications of Optimal Control Theory to Computer Controller Design

Optimal Control Systems

Optimal Control Theory for Applications

Optimal Control of Dynamic Systems Driven by Vector Measures

Optimal Control Theory

The published material represents the outgrowth of teaching analytical optimization to aerospace engineering graduate students. To make the material available to the widest audience, the prerequisites are limited to calculus and differential equations. It is also a book about the mathematical aspects of optimal control theory. It was developed in an engineering environment from material learned by the author while applying it to the solution of engineering problems. One goal of the book is to help engineering graduate students learn the fundamentals which are needed to apply the methods to engineering problems. The examples are from geometry and elementary dynamical systems so that they can be understood by all engineering students. Another goal of this text is to unify optimization by using the differential of calculus to create the Taylor series expansions needed to derive the optimality conditions of optimal control theory.

The performance of a process -- for example, how an aircraft consumes fuel -- can be enhanced when the most effective controls and operating points for the process are determined. This holds true for many physical, economic, biomedical, manufacturing, and engineering processes whose behavior can often be influenced by altering certain parameters or controls to optimize some desired property or output.

This book gathers the most essential results, including recent ones, on linear-quadratic optimal control problems, which represent an important aspect of stochastic control. It presents the results in the context of finite and infinite horizon problems, and discusses a number of new and interesting issues. Further, it precisely identifies, for the first time, the interconnections between three well-known, relevant issues - the existence of optimal controls, solvability of the optimality system, and solvability of the associated Riccati equation. Although the content is largely self-contained, readers should have a basic grasp of linear algebra, functional analysis and stochastic ordinary differential equations. The book is mainly intended for senior undergraduate and graduate students majoring in applied mathematics who are interested in stochastic control theory.

However, it will also appeal to researchers in other related areas, such as engineering, management, finance/economics and the social sciences.

"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, Tr'oltzsch 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."--Publisher's description.

Optimal Control: Novel Directions and Applications

Theory, Methods, and Applications

Nonlinear and Optimal Control Theory

Theory, Algorithms, and Applications

Theory and Applications

Upper-level undergraduate text introduces aspects of optimal control theory: dynamic programming, Pontryagin's minimum principle, and numerical techniques for trajectory optimization. Numerous figures, tables. Solution guide available upon request. 1970 edition.

This textbook offers a concise yet rigorous introduction to calculus of variations and optimal control theory, and is a resource for graduate students in engineering, applied mathematics, and related subjects. Designed specifically for a course, the book begins with calculus of variations, preparing the ground for optimal control. It then gives a complete maximum principle and covers key topics such as the Hamilton-Jacobi-Bellman theory of dynamic programming and linear quadratic optimal control. Calculus of Variations and Optimal Control Theory also traces the historical development of the subject and features numerous exercises, notes and references at the end of each chapter, and suggestions for further study. This is a yet rigorous introduction Requires limited background in control theory or advanced mathematics Provides a complete maximum principle Uses consistent notation in the exposition of classical and modern topics Traces the historical development of the subject Solutions manual (available only to teachers) Leading universities that have adopted this book include: University of Illinois at Urbana-Champaign ECE 553: Optimum Control Systems Georgia Institute of Technology ECE 6553: Optimal Control and Trajectory Optimization University of Pennsylvania ESE 680: Optimal Control Theory University of Notre Dame EE 60565: Optimal Control Theory Optimal control theory is a technique being used increasingly by academic economists to study problems involving optimization in a multi-period framework. This textbook is designed to make the difficult subject of optimal control theory easily accessible to economists while at the same time maintaining rigour. Economic intuitions are emphasized, and examples and problems are drawn from a wide range of applications in economics are provided to assist in the learning process. Theorems are clearly stated and proofs are carefully explained. The development of the text is gradual and fully integrated, beginning with simple forms and progressing to advanced topics such as control parameters, jumps in state variables, and bounded state space. For generality and elegance, optimal control theory is introduced directly, without recourse to the calculus of variations. The connection between optimal control theory and static optimization is explained in a separate chapter. A second purpose of the book is to draw the connection between optimal control theory and static optimization. Chapter 1 provides an extensive treatment of constrained optimization, with emphasis on economic insight and applications. Starting from basic concepts, it derives and explains important results, including the envelope theorem and the method of comparative statics. This chapter may be used for a course in static optimization. The book is largely self-contained. No previous knowledge of differential equations is required.

Splines, both interpolatory and smoothing, have a long and rich history that has largely been application driven. This book introduces these constructions in a comprehensive and accessible way, drawing from the latest methods and applications to show how they arise naturally in the theory of linear control systems. Magnus Egerstedt and Clyde Martin are leading innovators in the use of theoretic splines to bring together many diverse applications within a common framework. In this book, they begin with simple problems ranging from path planning to statistics to approximation. Using the tools of optimization over vector spaces and splines, Egerstedt and Martin demonstrate how all of these problems are part of the same general mathematical framework, and how they

certain degree, a consequence of the optimization problem of finding the shortest distance from a point to an affine Hilbert space. They cover periodic splines, monotone splines, and splines with inequality constraints, and explain how number of linear constraints can be added. This book reveals how the many natural connections between control theory, analysis, and statistics can be used to generate powerful mathematical and analytical tools. This book is an excellent text for students and professionals in control theory, robotics, engineering, computer graphics, econometrics, and any area that involves the construction of curves based on sets of raw data.

Foundations of Dynamic Economic Analysis

Stochastic Linear-Quadratic Optimal Control Theory: Open-Loop and Closed-Loop Solutions

A Concise Introduction

Optimal Control Theory and Static Optimization in Economics

A Control Parametrization Approach

Focusing on applications to science and engineering, this book presents the results of the ITN-FP7 SADCO network's innovative research in optimization and control in the following interconnected topics: optimality conditions in optimal control, dynamic programming approaches to optimal feedback synthesis and reachability analysis, and computational developments in model predictive control. The novelty of the book resides in the fact that it has been developed by early career researchers, providing a good balance between clarity and scientific rigor. Each chapter features an introduction addressed to PhD students and some original contributions aimed at specialist researchers. Requiring only a graduate mathematical background, the book is self-contained. It will be of particular interest to graduate and advanced undergraduate students, industrial practitioners and to senior scientists wishing to update their knowledge.

Optimal Control Theory and its Applications