

Applied Optimal Control Optimization Estimation And Control

Many engineering and scientific problems in design, control, and parameter estimation can be formulated as optimization problems that are governed by partial differential equations (PDEs). The complexities of the PDEs--and the requirement for rapid solution--pose significant difficulties. A particularly challenging class of PDE-constrained optimization problems is characterized by the need for real-time solution, i.e., in time scales that are sufficiently rapid to support simulation-based decision making. Real-Time PDE-Constrained Optimization, the first book devoted to real-time optimization for systems governed by PDEs, focuses on new formulations, methods, and algorithms needed to facilitate real-time, PDE-constrained optimization. In addition to presenting state-of-the-art algorithms and formulations, the text illustrates these algorithms with a diverse set of applications that includes problems in the areas of aerodynamics, biology, fluid dynamics, medicine, chemical processes, homeland security, and structural dynamics. Audience: readers who have experience in simulation and are interested in incorporating optimization into their simulations, who have expertise in numerical optimization and are interested in adapting optimization methods to the class of infinite-dimensional simulation problems, or who have worked in "offline" optimization contexts and are interested in moving to "online" optimization.

The theory of optimal control systems has grown and flourished since the 1960's. Many books 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 the 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 solid bridge between "traditional" optimization using the calculus of variations and what is called "modern" optimal control. It also treats both continuous-time and discrete-time optimal control 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 optimal control systems and as a quick reference for working engineers.

Here a leading researcher provides a comprehensive treatment of the design of automatic control logic for spacecraft and aircraft. In this book Arthur Bryson describes the linear quadratic-regulator (LQR) method of feedback control synthesis, which coordinates multiple controls, producing graceful maneuvers comparable to those of an expert pilot. The first half of the work is about attitude control of rigid and flexible spacecraft using momentum wheels, spin, fixed thrusters, and gimballed engines. Guidance for nearly circular orbits is discussed. The second half is about aircraft attitude and flight path control. This section discusses autopilot designs for cruise, climb-descent, coordinated turns, and automatic landing. One chapter deals with controlling helicopters near hover, and another offers an introduction to the stabilization of aeroelastic instabilities. Throughout the book there is a strong emphasis

on the mathematical modeling necessary for designing a good feedback control system. The appendices summarize analysis of linear dynamic systems, synthesis of analog and digital feedback control, simulation, and modeling of flexible vehicles.

A graduate text providing broad coverage of linear multivariable control systems, including several new results and recent approaches.

Optimal Control Theory for Applications

Optimal State Estimation

Applied Optimal Control & Estimation

Applied optimal control

Optimal Control with Aerospace Applications

Practical Methods for Optimal Control and Estimation Using Nonlinear Programming

From the very beginning in the late 1950s of the basic ideas of optimal control, attitudes toward the topic in the scientific and engineering community have ranged from an excessive enthusiasm for its reputed capability of solving almost any kind of problem to an (equally) unjustified rejection of it as a set of abstract mathematical concepts with no real utility. The truth, apparently, lies somewhere between these two extremes.

Intense research activity in the field of optimization, in particular with reference to robust control issues, has caused it to be regarded as a source of numerous useful, powerful, and flexible tools for the control system designer. The new stream of research is deeply rooted in the well-established framework of linear quadratic gaussian control theory, knowledge of which is an essential requirement for a fruitful understanding of optimization. In addition, there appears to be a widely shared opinion that some results of variational techniques are particularly suited for an approach to nonlinear solutions for complex control problems. For these reasons, even though the first significant achievements in the field were published some forty years ago, a new presentation of the basic elements of classical optimal control theory from a tutorial point of view seems meaningful and contemporary. This text draws heavily on the content of the Italian language textbook "Controllo ottimo" published by Pitagora and used in a number of courses at the Politecnico di Milano.

Despite the vast research on energy optimization and process integration, there has to date been no synthesis linking these together. This book fills the gap, presenting optimization and integration in energy and process engineering. The content is based on the current literature and includes novel approaches developed by the authors. Various thermal and chemical systems (heat and mass exchangers, thermal and water networks, energy converters, recovery units, solar collectors, and separators) are considered. Thermodynamics, kinetics and economics are used to formulate and solve problems with constraints on process

rates, equipment size, environmental parameters, and costs. Comprehensive coverage of dynamic optimization of energy conversion systems and separation units is provided along with suitable computational algorithms for deterministic and stochastic optimization approaches based on: nonlinear programming, dynamic programming, variational calculus, Hamilton-Jacobi-Bellman theory, Pontryagin's maximum principles, and special methods of process integration. Integration of heat energy and process water within a total site is shown to be a significant factor reducing production costs, in particular costs of utilities for the chemical industry. This integration involves systematic design and optimization of heat exchangers and water networks (HEN and WN). After presenting basic, insight-based Pinch Technology, systematic, optimization-based sequential and simultaneous approaches to design HEN and WN are described. Special consideration is given to the HEN design problem targeting stage, in view of its importance at various levels of system design. Selected, advanced methods for HEN synthesis and retrofit are presented. For WN design a novel approach based on stochastic optimization is described that accounts for both grassroot and revamp design scenarios. Presents a unique synthesis of energy optimization and process integration that applies scientific information from thermodynamics, kinetics, and systems theory Discusses engineering applications including power generation, resource upgrading, radiation conversion and chemical transformation, in static and dynamic systems Clarifies how to identify thermal and chemical constraints and incorporate them into optimization models and solutions

A bottom-up approach that enables readers to master and apply the latest techniques in state estimation This book offers the best mathematical approaches to estimating the state of a general system. The author presents state estimation theory clearly and rigorously, providing the right amount of advanced material, recent research results, and references to enable the reader to apply state estimation techniques confidently across a variety of fields in science and engineering. While there are other textbooks that treat state estimation, this one offers special features and a unique perspective and pedagogical approach that speed learning: * Straightforward, bottom-up approach begins with basic concepts and then builds step by step to more advanced topics for a clear understanding of state estimation * Simple examples and problems that require only paper and pen to solve lead to an intuitive understanding of how theory works in practice * MATLAB(r)-based source code that corresponds to examples in the book, available on the author's

Web site, enables readers to recreate results and experiment with other simulation setups and parameters. Armed with a solid foundation in the basics, readers are presented with a careful treatment of advanced topics, including unscented filtering, high order nonlinear filtering, particle filtering, constrained state estimation, reduced order filtering, robust Kalman filtering, and mixed Kalman/H_∞ filtering. Problems at the end of each chapter include both written exercises and computer exercises. Written exercises focus on improving the reader's understanding of theory and key concepts, whereas computer exercises help readers apply theory to problems similar to ones they are likely to encounter in industry. With its expert blend of theory and practice, coupled with its presentation of recent research results, Optimal State Estimation is strongly recommended for undergraduate and graduate-level courses in optimal control and state estimation theory. It also serves as a reference for engineers and science professionals across a wide array of industries.

"Dynamic Optimization" takes an applied approach to its subject, offering many examples and solved problems that draw from aerospace, robotics, and mechanics. The abundance of thoroughly tested general algorithms and Matlab codes provide the reader with the practice necessary to master this inherently difficult subject, while the realistic engineering problems and examples keep the material interesting and relevant. FEATURES/BENEFITS Covers dynamic programming, relating it to the calculus of variations and optimal control, and neighboring optimum control (differential dynamic programming), a practical method for nonlinear feedback control. Includes a disk that contains 40 gradient and shooting codes, as well as codes that solve the time-varying Riccati equation (the DYNOPT Toolbox). These codes have been thoroughly tested on hundreds of problems. Contains many realistic examples and problems. Solutions to the examples and problems, as well as the codes that produce the figures, are included on the accompanying disk. Covers dynamic optimization with inequality constraints and singular arcs using inverse dynamic optimization (differential inclusion).

Second Edition

Advances in Applied Nonlinear Optimal Control

An Engineering Approach to Optimal Control and Estimation Theory

Theory, Algorithms, and Applications

Control Theoretic Splines

A focused presentation of how sparse optimization methods can be used to solve optimal control and estimation problems.

An excellent introduction to feedback control system design, this book offers a

theoretical approach that captures the essential issues and can be applied to a wide range of practical problems. Its explorations of recent developments in the field emphasize the relationship of new procedures to classical control theory, with a focus on single input and output systems that keeps concepts accessible to students with limited backgrounds. The text is geared toward a single-semester senior course or a graduate-level class for students of electrical engineering. The opening chapters constitute a basic treatment of feedback design. Topics include a detailed formulation of the control design program, the fundamental issue of performance/stability robustness tradeoff, and the graphical design technique of loopshaping. Subsequent chapters extend the discussion of the loopshaping technique and connect it with notions of optimality. Concluding chapters examine controller design via optimization, offering a mathematical approach that is useful for multivariable systems.

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!

Systems that evolve with time occur frequently in nature and modelling the behavior of such systems provides an important application of mathematics. These systems can be completely deterministic, but it may be possible too to control their behavior by intervention through controls. The theory of optimal control is concerned with determining such controls which, at minimum cost, either direct the system along a given trajectory or enable it to reach a given point in its state space. 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 themes of the arguments but without using sophisticated mathematical tools. Problems in this setting can arise across a wide range of subjects and there are illustrative examples of systems from fields as diverse as dynamics, economics, population control, and medicine. Throughout there are many worked examples, and numerous exercises (with solutions) are provided.

Estimation, Simulation, and Control

Constrained Control and Estimation

Energy Optimization in Process Systems

Optimal Control

Calculus of Variations, Optimal Control Theory and Numerical Methods

Perturbation Analysis of Discrete Event Dynamic Systems

This book covers optimal design for multi-input/multi-output (MIMO) systems, providing not only the theoretical background, but also practical implementation techniques for control and estimation algorithms. Real-time implementation methods for a wide range of industries and control problems are detailed, including control of computer disk drives, chemical process control, and aircraft control. The book puts modern control design tools - based on solving matrix equation - well within the reach of the individual design engineer. You'll see how to design control systems using software programs, simulate these controllers on digital controllers, and then implement digital controllers on actual processors using digital signal processors (DSPs). Appropriate

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. Proceedings volume contains carefully selected papers presented during the 17th IFIP Conference on System Modelling and Optimization. Optimization theory and practice, optimal control, system modelling, stochastic optimization, and technical and non-technical applications of the existing theory are among areas mostly addressed in the included papers. Main directions are treated in addition to several survey papers based on invited presentations of leading specialists in the respective fields. Publication provides state-of-the-art in the area of system theory and optimization and points out several new areas (e.g fuzzy set, neural nets), where classical optimization topics intersects with computer science methodology. A NEW EDITION OF THE CLASSIC TEXT ON OPTIMAL CONTROL THEORY As a superb introductory text and an indispensable reference, this new edition of Optimal Control will serve the needs of both the professional engineer and the advanced student in mechanical, electrical, and aerospace engineering. Its coverage encompasses all the fundamental topics as well as the major changes that have occurred in recent years. An abundance of computer simulations using MATLAB and relevant Toolboxes is included to give the reader the actual

experience of applying the theory to real-world situations. Major topics covered include: Static Optimization Optimal Control of Discrete-Time Systems Optimal Control of Continuous-Time Systems The Tracking Problem and Other LQR Extensions Final-Time-Free and Constrained Input Control Dynamic Programming Optimal Control for Polynomial Systems Output Feedback and Structured Control Robustness and Multivariable Frequency-Domain Techniques Differential Games Reinforcement Learning and Optimal Adaptive Control

An Introduction to the Theory with Applications

Optimal Estimation of Dynamic Systems

Linear Multivariable Control Systems

Applied Linear Optimal Control Paperback with CD-ROM

Optimization in Control Applications

Calculus of Variations and Optimal Control Theory

This book is a printed edition of the Special Issue "Optimization in Control Applications" that was published in MCA

This best-selling text focuses on the analysis and design of complicated dynamics systems. CHOICE called it "a high-level, concise book that could well be used as a reference by engineers, applied mathematicians, and undergraduates. The format is good, the presentation clear, the diagrams instructive, the examples and problems helpful...References and a multiple-choice examination are included."

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CD-ROM contains: MATLAB codes of the OPTTEST toolbox -- Code for examples, figures, and selected problems in text.

Optimization, Estimation and Control

Applied Optimal Control

Optimal Control and Estimation

Estimation with Applications to Tracking and Navigation

An Optimisation Approach

Optimization, Estimation, and Control

How do you fly an airplane from one point to another as fast as possible? What is the best way to administer a vaccine to fight the harmful effects of disease? What is the most efficient way to produce a chemical substance? This book presents practical methods for solving real optimal control problems such as these. Practical Methods for Optimal Control Using Nonlinear Programming, Third Edition focuses on the direct transcription method for optimal control. It features a summary of relevant material in constrained optimization, including nonlinear programming; discretization techniques appropriate for ordinary differential equations and differential-algebraic equations; and several examples and descriptions of computational algorithm formulations that implement this discretize-then-optimize strategy. The third edition has been thoroughly updated and includes new material on implicit Runge–Kutta discretization techniques, new chapters on partial differential equations and delay equations, and more than 70 test problems and open source FORTRAN code for all of the problems. This book will be

valuable for academic and industrial research and development in optimal control theory and applications. It is appropriate as a primary or supplementary text for advanced undergraduate and graduate students.

A comprehensive introduction to the tools, techniques and applications of convex optimization.

Splines, both interpolatory and smoothing, have a long and rich history that has largely been application driven. This book unifies 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 control theoretic splines to bring together many diverse applications within a common framework. In this book, they begin with a series of problems ranging from path planning to statistics to approximation. Using the tools of optimization over vector spaces, Egerstedt and Martin demonstrate how all of these problems are part of the same general mathematical framework, and how they are all, to a certain degree, a consequence of the optimization problem of finding the shortest distance from a point to an affine subspace in a Hilbert space. They cover periodic splines, monotone splines, and splines with inequality constraints, and explain how any finite number of linear constraints can be added. This book reveals how the many natural connections between control theory, numerical analysis, and statistics can be used to generate powerful mathematical and analytical tools. This book is an excellent resource for students and professionals in control theory, robotics, engineering, computer graphics, econometrics, and any area that requires the construction of curves based on sets of raw data.

A unique interdisciplinary foundation for real-world problemsolving Stochastic search and optimization techniques are used in a vast number of areas, including aerospace, medicine, transportation, and finance, to name but a few. Whether the goal is refining the design of a missile or aircraft, determining the effectiveness of a new drug, developing the most efficient timing strategies for traffic signals, or making investment decisions in order to increase profits, stochastic algorithms can help researchers and practitioners devise optimal solutions to countless real-world problems. Introduction to Stochastic Search and Optimization: Estimation, Simulation, and Control is a graduate-level introduction to the principles, algorithms, and practical aspects of stochastic optimization, including applications drawn from engineering, statistics, and computer science. The treatment is both rigorous and broadly accessible, distinguishing this text from much of the current literature and providing students, researchers, and practitioners with a strong foundation for the often-daunting task of solving real-world problems. The text covers a broad range of today's most widely used stochastic algorithms, including: Random search Recursive linear estimation Stochastic approximation Simulated annealing Genetic and evolutionary methods Machine (reinforcement) learning Model selection Simulation-based optimization Markov chain Monte Carlo Optimal experimental design The book includes over 130 examples, Web links to software and data sets, more than 250 exercises for the reader, and an extensive list of references. These features help make the text an invaluable resource for those interested in the theory or practice of stochastic search and optimization. Proceedings of the Seventeenth IFIP TC7 Conference on System Modelling and Optimization, 1995

Introduction to Stochastic Search and Optimization

Linear Quadratic Methods

An Introduction

The Calculus of Variations and Optimal Control in Economics and Management

A Concise Introduction

Graduate-level text provides introduction to optimal control theory for stochastic systems, emphasizing application of basic concepts to real problems.

Applied Optimal Control Optimization, Estimation and Control CRC Press

Most newcomers to the field of linear stochastic estimation go through a difficult process in understanding and applying the theory. This book minimizes the process while introducing the fundamentals of optimal estimation. *Optimal Estimation of Dynamic Systems* explores topics that are important in the field of control where the signals received are used to determine highly sensitive processes such as the flight path of a plane, the orbit of a space vehicle, or the control of a machine. The authors use dynamic models from mechanical and aerospace engineering to provide immediate results of estimation concepts with a minimal reliance on mathematical skills. The book documents the development of the central concepts and methods of optimal estimation theory in a manner accessible to engineering students, applied mathematicians, and practicing engineers. It includes rigorous theoretical derivations and a significant amount of qualitative discussion and judgements. It also presents prototype algorithms, giving detail and discussion to stimulate development of efficient computer programs and intelligent use of them. This book illustrates the application of optimal estimation methods to problems with varying degrees of analytical and numerical difficulty. It compares various approaches to help develop a feel for the absolute and relative utility of different methods, and provides many applications in the fields of aerospace, mechanical, and electrical engineering. Covers developments in bilinear systems theory Focuses on the control of open physical processes functioning in a non-equilibrium mode Emphasis is on three primary disciplines: modern differential geometry, control of dynamical systems, and optimization theory Includes applications to the fields of quantum and molecular computing, control of physical processes, biophysics, superconducting magnetism, and physical information science

Estimation and Control of Dynamical Systems

Practical Methods for Optimal Control Using Nonlinear Programming, Third Edition

optimization, estimation, and control

Optimization and Control of Bilinear Systems

Dynamic Optimization

Kalman, H Infinity, and Nonlinear Approaches

Dynamic Systems (DEDS) are almost endless: military C3I logistic systems, the emerg

ward of a metropolitan hospital, back offices of large insurance and brokerage firms, and spare part operations of multinational firms the point is the pervasive nature of dynamic systems in the daily life of human beings. Yet DESS is a relatively new phenomenon in dynamic systems studies. From the days of Galileo to Newton to quantum mechanics and cosmology to the present, dynamic systems in nature are primarily differential equations based and event driven. A large literature and endless success stories have been built up on such Continuous Variable Dynamic Systems (CVDS). It is, however, equally clear that DESS are fundamentally different from CVDS. They are event driven, asynchronous, mostly man-made and only became significant during the past generation. Increasingly, however, it can be argued that in the modern world our lives are being impacted by and dependent upon the efficient operation of such DESS. Yet compared to the successful paradigm of differential equations for CVDS, the mathematical modelling of DESS is in its infancy. Nor are there as many successful and established techniques for their analysis and synthesis. The purpose of this series is to provide the study and understanding of the modelling, analysis, control, and management of DESS. The idea of the series came from editing a special issue of the Proceedings of IEEE on DESS in 1988.

This book provides a comprehensive presentation of classical and advanced topics in the analysis and control of dynamical systems with an emphasis on stochastic control. Many aspects that are not easily found in a single text are provided, such as connections between control theory and mathematical finance, as well as differential games. The book is self-contained and emphasizes concepts rather than full rigor, targeting scientists who want to use control theory in their research in applied mathematics, engineering, economics, and management science. Examples and exercises are included throughout, which will be useful for PhD courses and graduate courses in general. Dr. Alain Bensoussan is Lars Magnus Ericsson Chair at UT Dallas and Director of the International Center for Decision and Risk Analysis which develops management research as it pertains to large-investment industrial projects that involve advanced technologies, applications and markets. He is also Chair Professor at City University of Hong Kong.

Numerous examples highlight this treatment of the use of linear quadratic Gaussian methods in control system design. It explores linear optimal control theory from an engineering viewpoint with illustrations of practical applications. Key topics include loop-recovery techniques, frequency shaping, and controller reduction. Numerous examples and complete solutions are provided in this edition.

Expert coverage of the design and implementation of state estimation algorithms for tracking and navigation Estimation with Applications to Tracking and Navigation treats the estimation of various quantities from inherently inaccurate remote observations. It explains state estimation by designing a balanced combination of linear systems, probability, and statistics. The authors provide a review of the necessary background mathematical techniques and offer an overview of the basic concepts in estimation. They then provide detailed treatments of all the major techniques in estimation with a focus on applying these techniques to real systems. Other features include Problems that apply theoretical material to real-world applications In-depth coverage of the Interacting Multiple Model (IMM) estimator Companion DynaEst(TM) software for MATLAB(TM) implementation of Kalman filters and IMM estimators Design guidelines for tracking filters Suitable for graduate engineering students and engineers working in remote sensing and tracking, Estimation with Applications to Tracking and Navigation provides comprehensive coverage of this important area.

Feedback Control Theory

Optimal Control, Statistics, and Path Planning

Digital Design & Implementation

Optimal Control Systems

A Primer on Pontryagin's Principle in Optimal Control

Real-time PDE-constrained Optimization

In its highly organized overview of all areas, the book examines the design of modern optimal controllers requiring the selection of a performance criterion, demonstrates optimization of linear systems with bounded controls and limited control effort, and considers nonlinearities and their effect on various types of signals.

Since its initial publication, this text has defined courses in dynamic optimization taught to economics and management science students. The two-part treatment covers the calculus of variations and optimal control. 1998 edition.

This volume discusses advances in applied nonlinear optimal control, comprising both theoretical analysis of the developed control methods and case studies about their use in robotics, mechatronics, electric power generation, power electronics, micro-electronics, biological systems, biomedical systems, financial systems and industrial production processes. The advantages of the nonlinear optimal control approaches which are developed here are that, by applying approximate linearization of the controlled systems' state-space description, one can avoid the elaborated state variables transformations (diffeomorphisms) which are required by global linearization-based control methods. The book also applies the control input directly to the power unit of the controlled systems and not on an equivalent linearized description, thus avoiding the inverse transformations met in global linearization-based control methods and the potential appearance of singularity problems. The method adopted here also retains the known advantages of optimal control, that is, the best trade-off between accurate tracking of reference setpoints and moderate variations of the control inputs. The book's findings on nonlinear optimal control are a substantial contribution to the areas of nonlinear control and complex dynamical systems, and will find use in several research and engineering disciplines and in practical applications.

Recent developments in constrained control and estimation have created a need for this comprehensive introduction to the underlying fundamental principles. These advances have significantly broadened the realm of application of constrained control. - Using the principal tools of prediction and optimisation, examples of how to deal with constraints are given, placing emphasis on model predictive control. - New results combine a number of methods in a unique way, enabling you to build on your background in estimation theory, linear control, stability theory and state-space methods. - Companion web site, continually updated by the authors.

Easy to read and at the same time containing a high level of technical detail, this self-contained, new approach to methods for constrained control in design will give you a full understanding of the subject.

System Modelling and Optimization

Convex Optimization

Examples and Algorithms

Dynamic Optimization, Second Edition

Theory Algorithms and Software

Control of Spacecraft and Aircraft

"Optimal Control" reports on new theoretical and practical advances essential for analysing and synthesizing optimal controls of dynamical systems governed by partial and ordinary differential equations. New necessary and sufficient conditions for optimality are given. Recent advances in numerical methods are discussed. These

have been achieved through new techniques for solving large-sized nonlinear programs with sparse Hessians, and through a combination of direct and indirect methods for solving the multipoint boundary value problem. The book also focuses on the construction of feedback controls for nonlinear systems and highlights advances in the theory of problems with uncertainty. Decomposition methods of nonlinear systems and new techniques for constructing feedback controls for state- and control constrained linear quadratic systems are presented. The book offers solutions to many complex practical optimal control problems.

EDITORIAL REVIEW: This book provides a guided tour in introducing optimal control theory from a practitioner's point of view. As in the first edition, Ross takes the contrarian view that it is not necessary to prove Pontryagin's Principle before using it. Using the same philosophy, the second edition expands the ideas over four chapters: In Chapter 1, basic principles related to problem formulation via a structured approach are introduced: What is a state variable? What is a control variable? What is state space? And so on. In Chapter 2, Pontryagin's Principle is introduced using intuitive ideas from everyday life: Like the process of "measuring" a sandwich and how it relates to costates. A vast number of illustrations are used to explain the concepts without going into the minutia of obscure mathematics. Mnemonics are introduced to help a beginner remember the collection of conditions that constitute Pontryagin's Principle. In Chapter 3, several examples are worked out in detail to illustrate a step-by-step process in applying Pontryagin's Principle. Included in this example is Kalman's linear-quadratic optimal control problem. In Chapter 4, a large number of problems from applied mathematics to management science are solved to illustrate how Pontryagin's Principle is used across the disciplines. Included in this chapter are test problems and solutions. The style of the book is easygoing and engaging. The classical calculus of variations is an unnecessary prerequisite for understanding optimal control theory. Ross uses original references to weave an entertaining historical account of various events. Students, particularly beginners, will embark on a minimum-time trajectory to applying Pontryagin's Principle.

This textbook offers a concise yet rigorous introduction to calculus of variations and optimal control theory, and is a self-contained resource for graduate students in engineering, applied mathematics, and related subjects. Designed specifically for a one-semester course, the book begins with calculus of variations, preparing the ground for optimal control. It then gives a complete proof of the 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. Offers a concise yet rigorous introduction Requires limited background in control theory or advanced mathematics Provides a complete proof of the 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 Optimization University of Pennsylvania ESE 680: Optimal Control Theory University of Notre Dame EE 60565: Optimal Control