Linear Optimal Control Systems

Optimal Control
Optimal Control Systems
An Introduction
with Real-Time Applications
Optimal Control Systems
An Introduction to the Theory and Its Applications
The Theory and Application of Linear Optimal Control
Optimal Control
Linear Systems
An Introduction to State-Space Methods
Optimization, Estimation and Control
Linear Optimal Control Systems
Linear Optimal Control Systems
Kalman Filtering
Optimal and Robust Control
Control System Design
Concepts of General System Theory in the Linear Optimal Control Problem
Linear Control Theory
Optimal Control Systems by AA Fel'Dbaum
Continuous Time Dynamical Systems
Design criterion for improving the sensitivity of linear optimal control systems
Optimal Control and Estimation
Optimal Control
Parallel Algorithms for Optimal Control of Large

Scale Linear Systems
Theory and Applications
Applied Linear Optimal Control Paperback with CD-ROM
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Nonlinear and Optimal Control Systems
Nonlinear and Optimal Control Theory
Optimal Control of Dynamic Systems Driven by Vector Measures
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Equivalence of Quadratic Performance Indices for Linear Optimal Control Systems
Optimal Control of Distributed Systems with Conjugation Conditions
An Algorithm for Linear Optimal Control Systems with State Space Constraints
Structure, Robustness, and Optimization
Linear Systems and Optimal Control
Linear Optimal Control
Optimal Control Of Singularly Perturbed Linear Systems And Applications
Applied Optimal Control

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Optimal Control Springer Science & Business Media Successfully classroom-tested at the graduate level, Linear Control Theory: Structure, Robustness, and Optimization covers three major areas of control engineering (PID control, robust control, and optimal control). It provides balanced coverage of elegant mathematical theory and useful engineering-oriented results. The first part of the book develops results relating to the design of PID and first-order controllers for continuous and discrete-time linear systems with possible delays. The second section deals with the robust stability and performance of systems under parametric and unstructured uncertainty. This section describes several elegant and sharp results, such as Kharitonov’s theorem and its extensions, the edge theorem, and the mapping theorem. Focusing on the optimal control of linear systems, the third part discusses the standard theories of the linear quadratic regulator, Hinfinity and l1 optimal control, and associated results. Written by recognized leaders in the field, this book explains how control theory can be applied to the design of real-world systems. It shows that the techniques of three term controllers, along with the results on robust and optimal control, are invaluable to developing and solving research problems in many areas of engineering. *Optimal Control*

Systems Springer

A knowledge of linear systems provides a firm foundation for the study of optimal control theory and many areas of system theory and signal processing. State-space techniques developed since the early sixties have been proved to be very effective. The main objective of this book is to present a brief and somewhat complete investigation on the theory of linear systems, with emphasis on these techniques, in both continuous-time and discrete-time settings, and to demonstrate an application to the study of elementary (linear and nonlinear) optimal control theory. An essential feature of the state-space approach is that both time-varying and time-invariant systems are treated systematically. When time-varying systems are considered, another important subject that depends very much on the state-space formulation is perhaps real-time filtering, prediction, and smoothing via the Kalman filter. This subject is treated in our monograph entitled "Kalman Filtering with Real-Time Applications" published in this Springer Series in Information Sciences (Volume 17). For time-invariant systems, the recent frequency domain approaches using the techniques of Adamjan, Arov, and Krein (also known as AAK), balanced realization, and oo H theory via Nevanlinna-Pick interpolation seem very promising, and this will be studied in our forthcoming monograph entitled "Mathematical Ap proach to Signal Processing and System Theory". The present elementary treatise on linear system theory should provide enough engineering and mathe of these two subjects. *An Introduction* Elsevier Optimal Networked Control Systems with MATLAB® discusses optimal controller design in discrete time for networked control systems (NCS). The authors apply several powerful modern control techniques in discrete time to the design of intelligent controllers for such NCS. Detailed derivations, rigorous stability proofs, computer simulation examples, and downloadable MATLAB® codes are included for each case. The book begins by providing background on NCS, networked imperfections, dynamical systems, stability theory, and stochastic optimal adaptive controllers in discrete time for linear and nonlinear systems. It lays the foundation for reinforcement learning-based optimal adaptive controller use for finite and infinite horizons. The text then: Introduces quantization effects for linear and nonlinear NCS, describing the design of stochastic adaptive controllers for a class of linear and nonlinear systems Presents two-player zero-sum game-theoretic formulation for linear systems in input–output form enclosed by a communication network Addresses the stochastic optimal control of nonlinear NCS by using neuro dynamic programming Explores stochastic optimal design for nonlinear two-player zero-sum games under communication constraints Treats an event-sampled distributed NCS to minimize transmission of state and control signals within the feedback loop via the communication network Covers distributed joint optimal network scheduling and control design for wireless NCS, as well as the effect of network protocols on the wireless NCS controller design An ideal reference for graduate students,

university researchers, and practicing engineers, Optimal Networked Control Systems with MATLAB® instills a solid understanding of neural network controllers and how to build them.
with Real-Time Applications
Springer
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

Optimal Control Systems

Cambridge University Press

Many practical control problems are dominated by characteristics such as state, input and operational constraints, alternations between different operating regimes, and the interaction of continuous-time and discrete event systems. At present no methodology is available to design controllers in a systematic manner for such systems. This book introduces a new design theory for controllers for such constrained and switching dynamical systems and leads to algorithms that systematically solve control synthesis problems. The first part is a self-contained introduction to multiparametric programming, which is the main technique used to study and compute state feedback optimal control laws. The book's main objective is to derive properties of the state feedback solution, as well as to obtain algorithms to compute it efficiently. The focus is on constrained linear systems and constrained linear hybrid systems. The applicability of the theory is demonstrated through two experimental case studies: a mechanical laboratory process and a traction control system developed jointly with the Ford Motor Company in Michigan.

An Introduction to the Theory and Its Applications
CRC Press
In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering

under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and specific, but also generic, techniques for study of systems theory ant its particular branches, such as optimal filtering and information compression. - Best operator approximation, - Non-Lagrange interpolation, - Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear filtering

The Theory and Application of Linear Optimal Control Courier Corporation
Highlighing the Hamiltonian approach to singularly perturbed linear optimal control systems, this volume develops parallel algorithms in independent slow and fast time scales to solve various optimal linear control and filtering problems.

Optimal Control CRC Press
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. Courier Corporation 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 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 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 as a quick reference for working engineers.

Linear Systems

Courier Corporation "This book attempts to reconcile modern linear control theory with classical control theory. One of the major concerns of this text is to present design methods, employing modern techniques, for obtaining control systems that stand up to the requirements that have been so well developed in the classical expositions of control theory. Therefore, among other things, an entire chapter is devoted to a description of the analysis of control systems, mostly following the classical lines of thought. In the later chapters of the book, in which modern synthesis methods are developed, the chapter on analysis is recurrently referred to. Furthermore, special attention is paid to subjects that are standard in classical control theory but are frequently overlooked in modern treatments, such as nonzero set point control systems, tracking systems, and control systems that have to cope with constant disturbances. Also, heavy emphasis is placed upon the stochastic nature of control problems because the stochastic aspects are so essential." -- Preface.

An Introduction to State-Space Methods CRC Press
For more than forty years, the equation y’(t) = Ay(t) + u(t) in Banach spaces has been used as model for optimal control processes described by partial differential equations, in particular heat and diffusion processes. Many of the outstanding open problems, however, have remained open until recently, and some have never been solved. This book is a survey of all results know to the author, with emphasis on very recent results (1999 to date). The book is restricted to linear equations and two particular problems (the time optimal problem, the

norm optimal problem) which results in a more focused and concrete treatment. As experience shows, results on linear equations are the basis for the treatment of their semilinear counterparts, and techniques for the time and norm optimal problems can often be generalized to more general cost functionals. The main object of this book is to be a state-of-the-art monograph on the theory of the time and norm optimal controls for y’(t) = Ay(t) + u(t) that ends at the very latest frontier of research, with open problems and indications for future research. Key features: · Applications to optimal diffusion processes. · Applications to optimal heat propagation processes. · Modelling of optimal processes governed by partial differential equations. · Complete bibliography. · Includes the latest research on the subject. · Does not assume anything from the reader except basic functional analysis. · Accessible to researchers and advanced graduate students alike · Applications to optimal diffusion processes. · Applications to optimal heat propagation processes. · Modelling of optimal processes governed by partial differential equations. · Complete bibliography. · Includes the latest research on the subject. · Does not assume anything from the reader except basic functional analysis. · Accessible to researchers and advanced graduate students alike Optimization, Estimation and Control Springer Numerous examples highlight this treatment of the use of linear quadratic Gaussian methods for 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. 1990 edition. **Linear Optimal Control Systems** CRC Press Linear Optimal Control SystemsLinear Optimal Control SystemsWiley-Interscience Linear Optimal Control Systems Courier Corporation 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.

Kalman Filtering

Springer Nature

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.

Optimal and Robust Control Elsevier Preface; List of symbols; Introduction; Analysis of control systems; Multivariable systems; Vector random processes; Performance; Robustness; The linear quadratic regulator; The Kalman filter; Linear quadratic Gaussian control; Control; Ful information control estimation; H [infinity symbol] output feedback; Controller order reduction; Appendix: Mathematical notes.

Control System Design Linear Optimal Control SystemsLinear Optimal Control Systems Linear optimal control theory has produced an important synthesis technique for the design of linear multivariable systems. In the present study, efficient design procedures, based on the general optimal theory, have been developed. These procedures make use of design techniques which are similar to the conventional methods of control system analysis. Specifically, a scalar expression is developed which relates the closed-loop poles of the multi-controller, multi-output optimal system to the weighting parameters of a quadratic performance index. Methods analogous to the root locus and Bode plot techniques are then developed for the systematic analysis of this expression. Examples using the aircraft longitudinal equations of motion to represent the object to be controlled are presented to illustrate design procedures which can be carried out in either the time or frequency domains. Both the model-in - the-performance-index and model-following concepts are employed in several of the examples to illustrate the model approach to optimal design. Concepts of General System Theory in the Linear Optimal Control Problem 1973. Parallel Algorithms for Optimal Control of Large Scale Linear Systems is a comprehensive presentation for both linear and bilinear systems. The parallel algorithms presented in this book are applicable to a wider class of practical systems than those served by traditional methods for large scale singularly

perturbed and weakly coupled systems based on the power-series expansion methods. It is intended for scientists and advance graduate students in electrical engineering and computer science who deal with parallel algorithms and control systems, especially large scale systems. The material presented is both comprehensive and unique. *Linear Control Theory* CRC Press
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 ofsolving 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 ofwhich 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 ofthe basic elements ofclassical optimal control theory from a tutorial point of view seems meaningful and contemporary. This text draws heavily on the content ofthe Italian language textbook "Con trollo ottimo" published by Pitagora and used in a number of courses at the Politec nico of Milan. *Optimal Control Systems by AA Fel'Dbaum* Prentice Hall 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 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 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 as a quick reference for working engineers.