Advanced Mathematical Tools For Control Engineers

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Linear Control Systems Elsevier

Advanced Mathematical Tools for Control Engineers: Volume 1 provides a blend of Matrix and Linear Algebra Theory, Analysis, Differential Equations, Optimization, Optimal and Robust Control. It contains an advanced mathematical tool which serves as a fundamental basis for both instructors and students who study or actively work in Modern Automatic Control or in its applications. It is includes proofs of all theorems and contains many examples with solutions. It is written for researchers, engineers, and advanced students who wish to increase their familiarity with different topics of modern and classical mathematics related to System and Automatic Control Theories. Provides comprehensive theory of matrices, real, complex and functional analysis Provides practical examples of modern optimization methods that can be effectively used in variety of real-world applications Contains worked proofs of all theorems and propositions presented

Advanced Mathematical Tools for Control Engineers: Volume 1 Springer Science & Business Media

Geared primarily to an audience consisting of mathematically advanced undergraduate or beginning graduate students, this text may additionally be used by engineering students interested in a rigorous, proof-oriented systems course that goes beyond the classical frequency-domain material and more applied courses. The minimal mathematical background required is a working knowledge of linear algebra and differential equations. The book covers what constitutes the common core of control theory and is unique in its emphasis on foundational aspects. While covering a wide range of topics written in a standard theorem/proof style, it also develops the necessary techniques from scratch. In this second edition, new chapters and sections have been added, dealing with time optimal control of linear systems, variational and numerical approaches to nonlinear control, nonlinear controllability via Lie-algebraic methods, and controllability of recurrent nets and of linear systems with bounded controls.

The Robust Maximum Principle Springer Science & Business Media

The second edition of Mathematics as a Laboratory Tool reflects the growing impact that computational science is having on the career choices made by undergraduate science and engineering students. The focus is on dynamics and the effects of time delays and stochastic perturbations (“ noise ”) on the regulation provided by feedback control systems. The concepts are illustrated with applications to gene regulatory networks, motor control, neuroscience and population biology. The presentation in the first edition has been extended to include discussions of neuronal excitability and bursting, multistability, microchaos, Bayesian inference, second-order delay differential equations, and the semi-discretization method for the numerical integration of delay differential equations. Every effort has been made to ensure that the material is accessible to those with a background in calculus. The text provides advanced mathematical concepts such as the Laplace and Fourier integral transforms in the form of Tools. Bayesian inference is introduced using a number of detective-type scenarios including the Monty Hall problem.

Deterministic Techniques Cambridge University Press

This volume collects the refereed contributions based on the presentations made at the Seventh Workshop on Advanced Mathematical and Computational Tools in Metrology, a forum for metrologists, mathematicians and software engineers that will encourage a more effective synthesis of skills, capabilities and resources. The volume contains articles by world renowned metrologists and mathematicians involved in measurement science and, together with the six previous volumes in this series, constitutes an authoritative source of the mathematical, statistical and software tools necessary in modern metrology. Contents: Modeling Measurement Processes in Complex Systems with Partial Differential Equations: From Heat Conduction to the Heart (M Baer et al.); Mereotipological Approach for Measurement Software (E Benoit & R Dapoigny); Data Evaluation of Key Comparisons Involving Several Artefacts (M G Cox et al.); Box-Cox Transformations Versus Robust Control Charts in Statistical Process Control (M I Gomes & F O Figueiredo); Decision Making Using Sensor's Data Fusion and Kohonen Self Organizing Maps (P S Girao et al.); Generic System Design for Measurement Databases Applied to Calibrations in Vacuum Metrology, Bio-Signals and a Template System (H Gro et al.); Repeated Measurements: Evaluation of Their Uncertainty from the Viewpoints of Classical and Bayesian Statistics (I Lira & W Woger); Detection of Outliers in Interlaboratory Testing and Some Thoughts About Multivariate Precision (C Perruchet); On Appropriate Methods for the Validation of Metrological Software (D Richter et al.); Data Analysis-A Dialogue (D S Sivia); Validation of a Virtual Sensor for Monitoring Ambient Parameters (P Ciarlini et al.); Evaluation of Standard Uncertainties in Nested Structures (E Filipe); Linking GUM and ISO 5725 (A B Forbes); Monte Carlo Study on Logical and Statistical Correlation (B Siebert et al.); Some Problems Concerning the Estimate of the Uncertainty of the Degree of Equivalence in MRA Key Comparisons (F Pavese); Preparing for a European Research Area Network in Metrology: Where are We Now? (M Kuhne et al.); and other papers. Readership: Researchers, graduate students, academics and professionals in metrology.

Realization and Modelling in System Theory Springer Nature

A Relaxation Based Approach to Optimal Control of Hybrid and Switched Systems proposes a unified approach to effective and numerically tractable relaxation schemes for optimal control problems of hybrid and switched systems. The book gives an overview of the existing (conventional and newly developed) relaxation techniques associated with the conventional systems described by ordinary differential equations. Next, it constructs a self-contained relaxation theory for optimal control processes governed by various types (sub-classes) of general hybrid and switched systems. It contains all mathematical tools necessary for an adequate understanding and using of the sophisticated relaxation techniques. In addition, readers will find many practically oriented optimal control problems related to the new class of dynamic systems. All in all, the book follows engineering and numerical concepts. However, it can also be considered as a mathematical compendium that contains the necessary formal results and important algorithms related to the modern relaxation theory. Illustrates the use of the relaxation approaches in engineering optimization Presents application of the relaxation methods in computational schemes for a numerical treatment of the sophisticated hybrid/switched optimal control problems Offers a rigorous and self-contained mathematical tool for an adequate understanding and practical use of the relaxation techniques Presents an extension of the relaxation methodology to the new class of applied dynamic systems, namely, to hybrid and switched control systems

Mathematical Control Theory World Scientific

This open access Brief introduces the basic principles of control theory in a concise self-study guide. It complements the classic texts by emphasizing the simple conceptual unity of the subject. A novice can quickly see how and why the different parts fit together. The concepts build slowly and naturally one after another, until the reader soon has a view of the whole. Each concept is illustrated by detailed examples and graphics. The full software code for each example is available, providing the basis for experimenting with various assumptions, learning how to write programs for control analysis, and setting the stage for future research projects. The topics focus on robustness, design trade-offs, and optimality. Most of the book develops classical linear theory. The last part of the book considers robustness with respect to nonlinearity and explicitly nonlinear extensions, as well as advanced topics such as adaptive control and model predictive control. New students, as well as scientists from other backgrounds who want a concise and easy-to-grasp coverage of control theory, will benefit from the emphasis on concepts and broad understanding of the various approaches.

Topics on Mathematics for Smart Systems Springer Science & Business Media

Striking a careful balance between mathematical rigor and engineering-oriented applications, this textbook aims to maximize the reader's understanding of both the mathematical and engineering aspects of control theory. An invaluable book for junior and senior level university students in engineering, particularly electrical engineering.

Mathematics for Machine Learning Elsevier Science

Introduction to the Calculus of Variations and Control with Modern Applications provides the fundamental background required to develop rigorous necessary conditions that are the starting points for theoretical and numerical approaches to modern variational calculus and control problems. The book also presents some classical sufficient conditions and discusses the importance of distinguishing between the necessary and sufficient conditions. In the first part of the text, the author develops the calculus of variations and provides complete proofs of the main results. He explains how the ideas behind the proofs are essential to the development of modern optimization and control theory. Focusing on optimal control problems, the second part shows how optimal control is a natural extension of the classical calculus of variations to more complex problems. By emphasizing the basic ideas and their mathematical development, this book gives you the foundation to use these mathematical tools to then tackle new problems. The text moves from simple to more complex problems, allowing you to see how the fundamental theory can be modified to address more difficult and advanced challenges. This approach helps you understand how to deal with future problems and applications in a realistic work environment.

Robust Control of Linear Systems and Nonlinear Control Imperial College Press

A convenient single source for vital mathematical concepts, writtenby engineers and for engineers. Builds a strong foundation in modern applied mathematics forengineering students, and offers them a concise and comprehensivetreatment that summarizes and unifies their mathematical knowledgeusing a system focused on basic concepts rather than exhaustivetheorems and proofs. The authors provide several levels of explanation and exercisesinvolving increasing degrees of mathematical difficulty to recalland develop basic topics such as calculus, determinants, Gaussianelimination, differential equations, and functions of a complexvariable. They include an assortment of examples ranging fromsimple illustrations to highly involved problems as well as anumber of applications that demonstrate the concepts and methodsdiscussed throughout the book. This broad treatment also offers:*Key mathematical tools needed by engineers working incommunications, semiconductor device simulation, and control theory* Concise coverage of fundamental concepts such as sets, mappings,and linearity * Thorough discussion of topics such as distance,inner product, and orthogonality * Essentials of operatorequations, theory of approximations, transform methods, and partialdifferential equationsIt makes an excellent companion to lessgeneral engineering texts and a useful reference for practitioners.

Control Theory Tutorial World Scientific

This book is of interest to researchers in universities, research centres and industries who are involved in measurements and need advanced mathematical tools to solve their problems, and to whoever is working in the development of these mathematical tools. Advances in metrology depend on improvements in scientific and technical knowledge and in instrumentation quality as well in a better use of advanced mathematical tools and in the development of new ones. In this book scientists from both the mathematical and the metrological fields exchange their experiences. Industrial sectors such as instrumentation and software, are likely to benefit from this exchange, since metrology has a high impact on the overall quality of industrial products and applied mathematics is becoming more and more important in industrial processes. Contents:Bootstrap Algorithms and Applications (P Ciarlini)The TTRSs: 13 Oriented Constraints for Dimensioning, Tolerancing and Inspection (A Clement et al.)Graded Reference Data Sets and Performance Profiles for Testing Software Used in Metrology (M G Cox)Mathematical Methods for Data Analysis in Medical Applications (J Honerkamp)High-Dimensional Empirical Linear Prediction (H K Liu)Wavelet Methods in Signal Processing (P Maass)Software Problems in Calibration Services: A Case Study (N Greif et al.)Robust Alternatives to Least Squares (W Stahel)Magnetic Dipole Estimations for MCG-Data (E Krause)An Approximation Method for the Linearization of Tridimensional Metrology Problems (L Mathieu et al.)Quality of Experimental Data in Hydrodynamic Research (M Masia & R Penna)and other papers Readership: Applied mathematicians. keywords:Advanced Mathematical Tools;Metrology;Workshop;Proceedings;Berlin (Germany)

Topics on Mathematics for Smart Systems Springer Science & Business Media

This volume is the second of the three volume publication containing the proceedings of the 1989 International Symposium on the Mathemat ical Theory of Networks and Systems (MTNS-89), which was held in Amsterdam, The Netherlands, June 19-23, 1989 The International Symposia MTNS focus attention on problems from system and control theory, circuit theory and signal processing, which, in general, require application of sophisticated mathematical tools, such as from function and operator theory, linear algebra and matrix theory, differential and algebraic geometry. The interaction between advanced mathematical methods and practical engineering problems of circuits, systems and control, which is typical for MTNS, turns out to be most effective and is, as these proceedings show, a continuing source of exciting advances. The second volume contains invited papers and a large selection of other symposium presentations in the vast area of robust and nonlinear control. Modern developments in robust control and H-infinity theory, for finite as well as for infinite dimensional systems, are presented. A large part of the volume is devoted to nonlinear control. Special atten tion is paid to problems in robotics. Also the general theory of nonlinear and infinite dimensional systems is discussed. A couple of papers deal with problems of stochastic control and filterina. vi Preface The titles of the two other volumes are: Realization and Modelling in System Theory (volume 1) and Signal Processing, Scattering and Operator Theory, and Numerical Methods (volume 3).

Practical Methods for Optimal Control and Estimation Using Nonlinear Programming Cambridge University Press

The fundamental mathematical tools needed to understand machine learning include linear algebra, analytic geometry, matrix decompositions, vector calculus, optimization, probability and statistics. These topics are traditionally taught in disparate courses, making it hard for data science or computer science students, or professionals, to efficiently learn the mathematics. This self-contained textbook bridges the gap between mathematical and machine learning texts, introducing the mathematical concepts with a minimum of prerequisites. It uses these concepts to derive four central machine learning methods: linear regression, principal component analysis, Gaussian mixture models and support vector machines. For students and others with a

mathematical background, these derivations provide a starting point to machine learning texts. For those learning the mathematics for the first time, the methods help build intuition and practical experience with applying mathematical concepts. Every chapter includes worked examples and exercises to test understanding. Programming tutorials are offered on the book's web site.

Mathematical Control Theory and Finance SIAM

In various scientific and industrial fields, stochastic simulations are taking on a new importance. This is due to the increasing power of computers and practitioners ' aim to simulate more and more complex systems, and thus use random parameters as well as random noises to model the parametric uncertainties and the lack of knowledge on the physics of these systems. The error analysis of these computations is a highly complex mathematical undertaking. Approaching these issues, the authors present stochastic numerical methods and prove accurate convergence rate estimates in terms of their numerical parameters (number of simulations, time discretization steps). As a result, the book is a self-contained and rigorous study of the numerical methods within a theoretical framework. After briefly reviewing the basics, the authors first introduce fundamental notions in stochastic calculus and continuous-time martingale theory, then develop the analysis of pure-jump Markov processes, Poisson processes, and stochastic differential equations. In particular, they review the essential properties of It ô integrals and prove fundamental results on the probabilistic analysis of parabolic partial differential equations. These results in turn provide the basis for developing stochastic numerical methods, both from an algorithmic and theoretical point of view. The book combines advanced mathematical tools, theoretical analysis of stochastic numerical methods, and practical issues at a high level, so as to provide optimal results on the accuracy of Monte Carlo simulations of stochastic processes. It is intended for master and Ph.D. students in the field of stochastic processes and their numerical applications, as well as for physicists, biologists, economists and other professionals working with stochastic simulations, who will benefit from the ability to reliably estimate and control the accuracy of their simulations.

Advanced Mathematical Tools In Metrology - Proceedings Of The International Workshop Springer Science & Business Media

Covering some of the key areas of optimal control theory (OCT), a rapidly expanding field, the authors use new methods to set out a version of OCT ' s more refined ' maximum principle. ' The results obtained have applications in production planning, reinsurance-dividend management, multi-model sliding mode control, and multi-model differential games. This book explores material that will be of great interest to post-graduate students, researchers, and practitioners in applied mathematics and engineering, particularly in the area of systems and control.

Advanced Mathematical and Computational Tools in Metrology and Testing VIII Springer

This volume is the first of the three volume publication containing the proceedings of the 1989 International Symposium on the Mathematical Theory of Networks and Systems (MTNS-89), which was held in Amsterdam, The Netherlands, June 19-23, 1989. The International Symposia MTNS focus attention on problems from system and control theory, circuit theory and signal processing, which, in general, require application of sophisticated mathematical tools, such as from function and operator theory, linear algebra and matrix theory, differential and algebraic geometry. The interaction between advanced mathematical methods and practical engineering problems of circuits, systems and control, which is typical for MTNS, turns out to be most effective and is, as these proceedings show, a continuing source of exciting advances. The first volume contains invited papers and a large selection of other symposium presentations on the general theory of deterministic and stochastic systems with an emphasis on realization and modelling. A wide variety of recent results on approximate realization and system identification, stochastic dynamical systems, discrete event systems,- o systems, singular systems and nonstandard models IS presented. Preface vi Also a few papers on applications in hydrology and hydraulics are included. The titles of the two other volumes are: Robust Control of Linear Sys tems and Nonlinear Control (volume 2) and Signal Processing. Scatter ing and Operator Theory. and Numerical Methods (volume 3). The Editors are most grateful to the about 300 reviewers for their help in the refereeing process. The Editors thank Ms. G. Bijleveld and Ms.

Advanced Control Design with Application to Electromechanical Systems Butterworth-Heinemann

Advanced Mathematical Tools for Control Engineers: Volume 1 provides a blend of Matrix and Linear Algebra Theory, Analysis, Differential Equations, Optimization, Optimal and Robust Control. It contains an advanced mathematical tool which serves as a fundamental basis for both instructors and students who study or actively work in Modern Automatic Control or in its applications. It is includes proofs of all theorems and contains many examples with solutions. It is written for researchers, engineers, and advanced students who wish to increase their familiarity with different topics of modern and classical mathematics related to System and Automatic Control Theories. Provides comprehensive theory of matrices, real, complex and functional analysis Provides practical examples of modern optimization methods that can be effectively used in variety of real-world applications Contains worked proofs of all theorems and propositions presented

A Mathematical Introduction to Control Theory Elsevier

Control theory provides a large set of theoretical and computational tools with applications in a wide range of ?elds, running from " pure " branches of mathematics, like geometry, to more applied areas where the objective is to ?nd solutions to " real life " problems, as is the case in robotics, control of industrial processes or ?nance. The " high tech " character of modern business has increased the need for advanced methods. These rely heavily on mathematical techniques and seem indispensable for competitiveness of modern enterprises. It became essential for the ?nancial analyst to possess a high level of mathematical skills. C- versely, the complex challenges posed by the problems and models relevant to ?nance have, for a long time, been an important source of new research topics for mathematicians. The use of techniques from stochastic optimal control constitutes a well established and important branch of mathematical ?nance. Up to now, other branches of control theory have found comparatively less application in ?n- cial problems. To some extent, deterministic and stochastic control theories developed as di?erent branches of mathematics. However, there are many points of contact between them and in recent years the exchange of ideas between these ?elds has intensi?ed. Some concepts from stochastic calculus (e.g., rough paths) havedrawnthe attentionofthedeterministiccontroltheorycommunity.Also, some ideas and tools usual in deterministic control (e.g., geometric, algebraic or functional-analytic methods) can be successfully applied to stochastic c- trol.

Advanced Mathematical Tools for Automatic Control Engineers: Volume 2 CRC Press

The main theme of the AMCTM 2008 conference, reinforced by the establishment of IMEKO TC21, was to provide a central opportunity for the metrology and testing community worldwide to engage with applied mathematicians, statisticians and software engineers working in the relevant fields. This review volume consists of reviewed papers prepared on the basis of the oral and poster presentations of the Conference participants. It covers all the general matters of advanced statistical modeling (e.g. uncertainty evaluation, experimental design, optimization, data analysis and applications, multiple measurands, correlation, etc.), metrology software (e.g. engineering aspects, requirements or specification, risk assessment, software development, software examination, software tools for data analysis, visualization, experiment control, best practice, standards, etc.), numerical methods (e.g. numerical data analysis, numerical simulations, inverse problems, uncertainty evaluation of numerical algorithms, applications, etc.), and data fusion techniques and design and analysis of inter-laboratory comparisons.

Advanced Mathematical Tools in Metrology III Butterworth-Heinemann

Anyone seeking a gentle introduction to the methods of modern control theory and engineering, written at the level of a first-year graduate course, should consider this book seriously. It contains: A generous historical overview of automatic control, from Ancient Greece to the 1970s, when this discipline matured into an essential field for electrical, mechanical, aerospace, chemical, and biomedical engineers, as well as mathematicians, and more recently, computer scientists; A balanced presentation of the relevant theory: the main state-space methods for description, analysis, and design of linear control systems are derived, without overwhelming theoretical arguments; Over 250 solved and exercise problems for both continuous- and discrete-time systems, often including MATLAB simulations; and Appendixes on MATLAB, advanced matrix theory, and the history of mathematical tools such as differential calculus, transform methods, and linear algebra. Another noteworthy feature is the frequent use of an inverted pendulum on a cart to illustrate the most important concepts of automatic control, such as: Linearization and discretization; Stability, controllability, and observability; State feedback, controller design, and optimal control; and Observer design, reduced order observers, and Kalman filtering. Most of the problems are given with solutions or MATLAB simulations. Whether the book is used as a textbook or as a self-study guide, the knowledge gained from it will be an excellent platform for students and practising engineers to explore further the recent developments and applications of control theory.

Advanced Mathematical and Computational Tools in Metrology VII Wiley-Interscience

Since its reform and opening up, China has experienced unprecedented social and economic development. It is important to understand the biggest and fastest growing economy's policy and strategy. As a key director in Party School of the Central Committee of the Communist Party of China, the author proposes a development path and reform strategies for China in the next three decades.This book suggests reform strategies not only for the economic structure but also for the political system in China. The author makes a sound analysis and exposition of " Chinese dream ", which reflects the vision of a better life in the future and the main indicators of social change. The book investigates China's development path, political system, economic structure, people's livelihood etc and suggests long-term strategies for China in this regard.