



Mathematical Problems of Control Theory

An Introduction

Gennady A. Leonov



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Mathematical Problems Of Control Theory An Introduction

Donald E. Kirk



Mathematical Problems Of Control Theory An Introduction:

Mathematical Problems of Control Theory Gennadi? Alekseevich Leonov, 2001 This book shows clearly how the study of concrete control systems has motivated the development of the mathematical tools needed for solving such problems In many cases by using this apparatus far reaching generalizations have been made and its further development will have an important effect on many fields of mathematics In the book a way is demonstrated in which the study of the Watt flyball governor has given rise to the theory of stability of motion The criteria of controllability observability and stabilization are stated Analysis is made of dynamical systems which describe an autopilot spacecraft orientation system controllers of a synchronous electric machine and phase locked loops The Aizerman and Brockett problems are discussed and an introduction to the theory of discrete control systems is given Contents The Watt Governor and the Mathematical Theory of Stability of Motion Linear Electric Circuits Transfer Functions and Frequency Responses of Linear Blocks Controllability Observability Stabilization Two Dimensional Control Systems Phase Portraits Discrete Systems The Aizerman Conjecture The Popov Method Readership Applied mathematicians and mechanical engineers Mathematical Problems Of Control Theory: An Introduction

Gennady A Leonov, 2001-11-28 This book shows clearly how the study of concrete control systems has motivated the development of the mathematical tools needed for solving such problems In many cases by using this apparatus far reaching generalizations have been made and its further development will have an important effect on many fields of mathematics In the book a way is demonstrated in which the study of the Watt flyball governor has given rise to the theory of stability of motion The criteria of controllability observability and stabilization are stated Analysis is made of dynamical systems which describe an autopilot spacecraft orientation system controllers of a synchronous electric machine and phase locked loops The Aizerman and Brockett problems are discussed and an introduction to the theory of discrete control systems is given

Optimal Control Theory Donald E. Kirk, 2012-04-26 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 **Mathematical**

Control Theory Jerzy Zabczyk, 2008 In a mathematically precise manner this book presents a unified introduction to deterministic control theory It includes material on the realization of both linear and nonlinear systems impulsive control and positive linear systems *A Mathematical Introduction to Control Theory* Shlomo Engelberg, 2005 *Introduction to*

Optimal Control Theory Jack Macki, Aaron Strauss, 2012-12-06 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 *An Introduction to Optimal Control Problems in Life Sciences and Economics* Sebastian Anița, Viorel Arnăutu, Vincenzo Capasso, 2011-05-05 Combining control theory and modeling this textbook introduces and builds on methods for simulating and tackling concrete problems in a variety of applied sciences Emphasizing learning by doing the authors focus on examples and applications to real world problems An elementary presentation of advanced concepts proofs to introduce new ideas and carefully presented MATLAB programs help foster an understanding of the basics but also lead the way to new independent research With minimal prerequisites and exercises in each chapter this work serves as an excellent textbook and reference for graduate and advanced undergraduate students researchers and practitioners in mathematics physics engineering computer science as well as biology biotechnology economics and finance **Open Problems in Mathematical Systems and Control Theory** Vincent D. Blondel, Eduardo D. Sontag, Mathukumalli Vidyasagar, Jan C. Willems, 2012-12-06 System and Control theory is one of the most exciting areas of contemporary engineering mathematics From the analysis of Watt's steam engine governor which enabled the Industrial Revolution to the design of controllers for consumer items chemical plants and modern aircraft the area has always drawn from a broad range of tools It has provided many challenges and possibilities for interaction between engineering and established areas of pure and applied mathematics This impressive volume collects a discussion of more than fifty open problems which touch upon a variety of subfields including chaotic observers nonlinear local controllability discrete event and hybrid systems neural network learning matrix inequalities Lyapunov exponents and many other issues Proposed and explained by leading researchers they are offered with the intention of generating further work as well as inspiration for many other similar problems which may naturally arise from them With extensive references this book will be a useful reference source as well as an excellent addendum to the textbooks in the area *Mathematical Control Theory* Eduardo D. Sontag, 2013-11-21 Mathematics is playing an ever more important role in the physical and biological sciences provoking a blurring of boundaries between scientific disciplines and a resurgence of interest in the modern as well as the classical techniques of applied mathematics This renewal of interest both in research and teaching has led to the establishment of the series Texts in Applied Mathematics TAM The development of new courses is a natural consequence of a

high level of excitement on the research frontier as newer techniques such as numerical and symbolic computer systems dynamical systems and chaos mix with and reinforce the traditional methods of applied mathematics. Thus the purpose of this textbook series is to meet the current and future needs of these advances and to encourage the teaching of new courses. TAM will publish textbooks suitable for use in advanced undergraduate and beginning graduate courses and will complement the Applied Mathematics Sciences AMS series which will focus on advanced textbooks and research level monographs.

Preface to the Second Edition The most significant differences between this edition and the first are as follows: Additional chapters and sections have been written dealing with nonlinear controllability via Lie algebraic methods; variational and numerical approaches to nonlinear control including a brief introduction to the Calculus of Variations and the Minimum Principle; time optimal control of linear systems; feedback linearization; single input case nonlinear optimal feedback; controllability of recurrent nets and controllability of linear systems with bounded controls.

An Introduction to Optimal Control Theory Aaron Strauss, 2012-12-06 This paper is intended for the beginner. It is not a state of the art paper for research workers in the field of control theory. Its purpose is to introduce the reader to some of the problems and results in control theory to illustrate the application of these results and to provide a guide for his further reading on this subject. I have tried to motivate the results with examples especially with one canonical simple example described in 3. Many results such as the maximum principle have long and difficult proofs. I have omitted these proofs. In general I have included only the proofs which are either 1 not too difficult or 2 fairly enlightening as to the nature of the result. I have however usually attempted to draw the strongest conclusion from a given proof. For example many existing proofs in control theory for compact targets and uniqueness of solutions also hold for closed targets and non uniqueness. Finally at the end of each section I have given references to generalizations and origins of the results discussed in that section. I make no claim of completeness in the references however as I have often been content merely to refer the reader either to an exposition or to a paper which has an extensive bibliography.

IV These lecture notes are revisions of notes I used for a series of nine lectures on control theory at the International Summer School on Mathematical Systems and Economics held in Varenna Italy June 1967.

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

equations and control theory for deterministic systems is the only prerequisite for reading this book Mathematical Control Theory John B. Baillieul, J.C. Willems, 2012-12-06 This volume on mathematical control theory contains high quality articles covering the broad range of this field The internationally renowned authors provide an overview of many different aspects of control theory offering a historical perspective while bringing the reader up to the very forefront of current research **Control Systems Engineering** Dr. Neeraj Kumar, Kaushik Neogi, Dr. Apurba Chatterjee, Mr. Mohamed Sameer T. K , 2025-10-24 Control Systems Engineering is a field of engineering that focuses on the analysis and design of systems that regulate their own behavior to achieve desired outputs It deals with understanding how to control dynamic systems such as electrical mechanical thermal hydraulic and robotic systems by using feedback and control strategies

Introduction to Control Theory O. L. R. Jacobs, 1974 **Mathematical Control Theory** W.A. Coppel, 2006-11-15 A *Course in Robust Control Theory* Geir E. Dullerud, Fernando Paganini, 2013-03-14 Research in robust control theory has been one of the most active areas of mainstream systems theory since the late 70s This research activity has been at the confluence of dynamical systems theory functional analysis matrix analysis numerical methods complexity theory and engineering applications The discipline has involved interactions between diverse research groups including pure mathematicians applied mathematicians computer scientists and engineers This research effort has produced a rather extensive set of approaches using a wide variety of mathematical techniques and applications of robust control theory are spreading to areas as diverse as control of fluids power networks and the investigation of feedback mechanisms in biology During the 90 s the theory has seen major advances and achieved a new maturity centered around the notion of convexity The goal of this book is to give a graduate level course on robust control theory that emphasizes these new developments but at the same time conveys the main principles and ubiquitous tools at the heart of the subject Its pedagogical objectives are to introduce a coherent and unified framework for studying robust control theory to provide students with the control theoretic background required to read and contribute to the research literature and to present the main ideas and demonstrations of the major results of robust control theory The book will be of value to mathematical researchers and computer scientists wishing to learn about robust control theory graduate students planning to do research in the area and engineering practitioners requiring advanced control techniques Mathematical Theory of Control Systems Design V.N. Afanasiev, V. Kolmanovskii, V.R. Nosov, 2013-04-17 Give and it shall be given unto you ST LUKE VI 38 The book is based on several courses of lectures on control theory and applications which were delivered by the authors for a number of years at Moscow Electronics and Mathematics University The book originally written in Russian was first published by Vysshaya Shkola Higher School Publishing House in Moscow in 1989 In preparing a new edition of the book we planned to make only minor changes in the text However we soon realized that we like many scholars working in control theory had learned many new things and had had many new insights into control theory and its applications since the book was first published Therefore

we rewrote the book especially for the English edition So this is substantially a new book with many new topics The book consists of an introduction and four parts Part One deals with the fundamentals of modern stability theory general results concerning stability and instability sufficient conditions for the stability of linear systems methods for determining the stability or instability of systems of various type theorems on stability under random disturbances

Geometric Control of Mechanical Systems Francesco Bullo, Andrew D. Lewis, 2019-06-12 The primary emphasis of this book is the modeling analysis and control of mechanical systems The methods and results presented can be applied to a large class of mechanical control systems including applications in robotics autonomous vehicle control and multi body systems The book is unique in that it presents a unified rather than an inclusive treatment of control theory for mechanical systems A distinctive feature of the presentation is its reliance on techniques from differential and Riemannian geometry The book contains extensive examples and exercises and will be suitable for a growing number of courses in this area It begins with the detailed mathematical background proceeding through innovative approaches to physical modeling analysis and design techniques Numerous examples illustrate the proposed methods and results while the many exercises test basic knowledge and introduce topics not covered in the main body of the text The audience of this book consists of two groups The first group is comprised of graduate students in engineering or mathematical sciences who wish to learn the basics of geometric mechanics nonlinear control theory and control theory for mechanical systems Readers will be able to immediately begin exploring the research literature on these subjects The second group consists of researchers in mechanics and control theory Nonlinear control theoreticians will find explicit links between concepts in geometric mechanics and nonlinear control theory Researchers in mechanics will find an overview of topics in control theory that have relevance to mechanics

Optimal Control Michael Athans, Peter L. Falb, 2013-04-26 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

Infinite Dimensional Optimization and Control Theory Hector O. Fattorini, 1999-03-28 Treats optimal problems for systems described by ODEs and PDEs using an approach that unifies finite

and infinite dimensional nonlinear programming

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