

Systems & Control: Foundations & Applications

Jerzy Zabczyk

# Mathematical Control Theory

An Introduction

Second Edition

 Birkhäuser

# Mathematical Control Theory

**Eduardo D. Sontag**



## **Mathematical Control Theory:**

**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 v 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

**Mathematical Control Theory** Jerzy Zabczyk, 1992 This book is designed as a graduate text on the mathematical theory of deterministic control It covers a remarkable number of topics The book includes material on the realization of both linear and nonlinear systems impulsive control and positive linear systems a subject not usually covered in an introductory book To get so much material in such a short space the pace of the presentation is brisk However the exposition is excellent and the book is a joy to read A novel one semester course covering both linear and nonlinear systems could be given The book is an excellent one for introducing a mathematician to control theory The book presents a large amount of material very well and its use is highly recommended a Bulletin of the AMS Mathematical Control Theory An Introduction presents in a mathematically precise manner a unified introduction to deterministic control theory With the exception of a few more advanced concepts required for the final part of the book this presentation requires only a knowledge of basic facts from linear algebra differential equations and calculus In addition to classical concepts and ideas the author covers the stabilization of nonlinear systems using topological methods realization theory for nonlinear systems impulsive control and positive systems the control of rigid bodies the stabilization of infinite dimensional systems and the solution of minimum energy problems The book will be ideal for a beginning graduate course in mathematical control theory or for self study by professionals needing a complete picture of the mathematical theory that underlies the applications of control theory

**Mathematical Control Theory** John Baillieul, Jan C. Willems, 1999 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

**Introduction to Mathematical Control Theory** Stephen Barnett,R. G. Cameron,1985 In this new edition of a successful text Professor Barnett now joined in the authorship by Dr Cameron has concentrated on adding material where topics have developed since the first edition and they have also taken advantage of the extensive classroom testing that has been possible in the intervening years The book remains the concise readable account of some basic mathematical aspects of control concentrating on state space methods and emphasizing points of mathematical interest As far as the additional material is concerned the new chapter on multivariable theory reflects some of the significant developments in that field during the past decade and there is also now an appendix on Kalman filtering All references have been updated and a large number of new problems for student use have been incorporated

Mathematical Control Theory Czesław Olech,Bronisław Jakubczyk,Jerzy Zabczyk,1985 **Introduction to Mathematical Control Theory** Stephen Barnett,S. Barnett,1975

Mathematical Control Theory and Finance Andrey Sarychev,Albert Shiryaev,Manuel Guerra,Maria do Rosário Grossinho,2009-03-31 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 ncial 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 havedrawntheattentionofthedeterministiccontroltheorycommunity 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

**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* W.A. Coppel,2006-11-15      **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

*Mathematical Control Theory* W. A. Coppel,2014-09-01      **Mathematical Control Theory** Jerzy Zabczyk,2009-11-03 *Mathematical Control Theory An Introduction* presents in a mathematically precise manner a unified introduction to deterministic control theory With the exception of a few more advanced concepts required for the final part of the book this presentation requires only a knowledge of basic facts from linear algebra differential equations and calculus In addition to classical concepts and ideas the author covers the stabilization of nonlinear systems using topological methods realization theory for nonlinear systems impulsive control and positive systems the control of rigid bodies the stabilization of infinite dimensional systems and the solution of minimum energy problems The book will be ideal for a beginning graduate course in mathematical control theory or for self study by professionals needing a complete picture of the mathematical theory that underlies the applications of control theory

**Introduction to Mathematical Control Theory** Stephen Barnett,1982      **Mathematical Control of Coupled PDEs** Irena Lasiecka,2002-01-01      **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

**Introduction to mathematical control theory** S. and Cameron R. G. Barnett, Oxford applied mathematics and computing science series, 1985 **A**

**Mathematical Introduction to Control Theory** Shlomo Engelberg, 2005 Mathematical Control Theory, 1985

**Nonlinear Optimal Control Theory** Leonard David Berkovitz, Negash G. Medhin, 2012-08-25 Nonlinear Optimal Control Theory presents a deep wide ranging introduction to the mathematical theory of the optimal control of processes governed by ordinary differential equations and certain types of differential equations with memory Many examples illustrate the mathematical issues that need to be addressed when using optimal control techniques in diverse areas Drawing on classroom tested material from Purdue University and North Carolina State University the book gives a unified account of bounded state problems governed by ordinary integrodifferential and delay systems It also discusses Hamilton Jacobi theory By providing a sufficient and rigorous treatment of finite dimensional control problems the book equips readers with the foundation to deal with other types of control problems such as those governed by stochastic differential equations partial differential equations and differential games

Mathematical Control Theory I M. Kanat Camlibel, A. Agung Julius, Ramkrishna Pasumathy, Jacquelin M.A. Scherpen, 2015-07-15 This treatment of modern topics related to mathematical systems theory forms the proceedings of a workshop Mathematical Systems Theory From Behaviors to Nonlinear Control held at the University of Groningen in July 2015 The workshop celebrated the work of Professors Arjan van der Schaft and Harry Trentelman honouring their 60th Birthdays The first volume of this two volume work covers a variety of topics related to nonlinear and hybrid control systems After giving a detailed account of the state of the art in the related topic each chapter presents new results and discusses new directions As such this volume provides a broad picture of the theory of nonlinear and hybrid control systems for scientists and engineers with an interest in the interdisciplinary field of systems and control theory The reader will benefit from the expert participants ideas on exciting new approaches to control and system theory and their predictions of future directions for the subject that were discussed at the workshop

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