Chapter 1

Introduction to Optimal Control

Introduction

- Optimal control — is finding a controller that drives a system towards a desired operating condition while achieving a given performance criteria

- The performance criteria is given as a cost function J

- Most co $J = \phi[x(t), t]\Big|_{t=t_0}^{t=t_f} + \int_{t_0}^{t_f} \phi[x(t), u(t), t]\,dt$

Introduction To Optimal Control

Leslie M. Hocking

Introduction To Optimal Control:

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 **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 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 re sults and to provide a guide for his further reading on this subject I have tried to motivate the results with examples especial ly 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 1ecture notes are revisions of notes I used for aseries of nine 1ectures on contro1 theory at the International Summer Schoo1 on Mathematica1 Systems and Economics held in Varenna Ita1y June 1967 *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 Introduction to Optimal Control Ian McCausland,1968 *Introduction to Control Theory, Including Optimal Control* David N. Burghes,Alexander Graham,1980 *An Introduction to Optimal Control* George Leitmann,1966 Optimal Control Theory Donald E. Kirk,1976 Optimal Control Leslie M. Hocking,1991 Systems that evolve with time occur frequently in nature and modelling the behaviour of such systems provides an important application of mathematics These systems can be completely deterministic but it may be possible too to control their behaviour 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 as diverse fields as dynamics economics population control and medicine Throughout there are many worked examples and numerous exercises with solutions are provided **Introduction to Optimal Control** I. McCausland,1977 Optimal Control Arturo Locatelli,2001-03 From the reviews The style of the book reflects the author s wish to assist in the effective learning of optimal control by suitable choice of topics the mathematical level used and by including numerous illustrated examples In my view the book suits its function and purpose in that it gives a student a comprehensive coverage of optimal control in an easy to read fashion Measurement and Control Lecture Notes Containing an Elementary Introduction to Optimal Control John Markus Blatt,1981 **An Introduction to Optimal Control Problems in Life Sciences and Economics** Sebastian Aniţa,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   *Optimal Control and Estimation* Robert F. Stengel,1994-09-20 An excellent introduction to optimal control and estimation theory and its relationship with LQG design invaluable as a reference for those already familiar with the subject Automatica This highly regarded graduate level text provides a comprehensive introduction to optimal control theory for stochastic systems emphasizing application of its basic concepts to real problems The first two chapters introduce optimal control and review the mathematics of control and estimation Chapter 3 addresses optimal control of systems that may be nonlinear and time varying but whose inputs and parameters are known without error Chapter 4 of the book presents methods for estimating the dynamic states of a system that is driven by uncertain forces and is observed with random measurement error Chapter 5 discusses the general problem of stochastic optimal control and the concluding chapter covers linear time invariant systems Robert F Stengel is Professor of Mechanical and Aerospace Engineering at Princeton University where he directs the Topical Program on Robotics and Intelligent Systems and the Laboratory for Control and Automation He was a principal designer of the Project Apollo Lunar Module control system An excellent teaching book with many examples and worked problems which would be ideal for self study or for use in the classroom The book also has a practical orientation and would be of considerable use to people applying these techniques in practice Short Book Reviews Publication of the International Statistical Institute An excellent book which guides the reader through most of the important concepts and techniques A useful book for students and their teachers and for those practicing engineers who require a comprehensive reference to the subject Library Reviews The Royal Aeronautical Society

Optimal Control Theory Suresh P. Sethi,2018-11-28 This fully revised 3rd edition offers an introduction to optimal control theory and its diverse applications in management science and economics It brings to students the concept of the maximum principle in continuous as well as discrete time by using dynamic programming and Kuhn Tucker theory While some mathematical background is needed the emphasis of the book is not on mathematical rigor but on modeling realistic situations faced in business and economics The book exploits optimal control theory to the functional areas of management including finance production and marketing and to economics of growth and of natural resources In addition this new edition features materials on stochastic Nash and Stackelberg differential games and an adverse selection model in the principal agent framework The book provides exercises for each chapter and answers to selected exercises to help deepen the understanding of the material presented Also included are appendices comprised of supplementary material on the solution of differential equations the calculus of variations and its relationships to the maximum principle and special topics including the Kalman filter certainty equivalence singular control a global saddle point theorem Sethi Skiba points and distributed

parameter systems Optimal control methods are used to determine optimal ways to control a dynamic system The theoretical work in this field serves as a foundation for the book which the author has applied to business management problems developed from his research and classroom instruction The new edition has been completely refined and brought up to date Ultimately this should continue to be a valuable resource for graduate courses on applied optimal control theory but also for financial and industrial engineers economists and operational researchers concerned with the application of dynamic optimization in their fields An Introduction to Optimal Control Yury Shestopalov,Elena Pronina,Roman Dzerzhinsky,2023-08-09 This book explores the major techniques involved in optimization control theory and calculus of variations The book serves as a concise contemporary guide to optimal control theory optimization numerical methods and beyond As such it is a valuable source to learn mathematical modeling and the mathematical nature of optimization and optimal control The presence of a variety of exercises solved down to numerical values is one of the main characteristic features of the book Another one is its compactness and the material s usefulness in preparing and teaching several different university courses The investigation of trends and their formation undertaken in the book leads seamlessly into extrapolation techniques and rigorous methods of scientific prediction The research for this book was accomplished at the Russian Technological University RTU MIREA based on the courses which have been taught at the RTU for many years *An Introduction to Applied Optimal Control* Knowles,1982-03-18 An Introduction to Applied Optimal Control **Calculus of Variations and Optimal Control Theory** Daniel Liberzon,2011-12-19 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 **An Introduction to Optimal Control Theory** Onésimo Hernández-Lerma,Leonardo R. Laura-Guarachi,Saul Mendoza-Palacios,David González-Sánchez,2023-03-25 This book introduces optimal control problems for large families of deterministic and stochastic systems with discrete or continuous time parameter These families include

most of the systems studied in many disciplines including Economics Engineering Operations Research and Management Science among many others The main objective is to give a concise systematic and reasonably self contained presentation of some key topics in optimal control theory To this end most of the analyses are based on the dynamic programming DP technique This technique is applicable to almost all control problems that appear in theory and applications They include for instance finite and infinite horizon control problems in which the underlying dynamic system follows either a deterministic or stochastic difference or differential equation In the infinite horizon case it also uses DP to study undiscounted problems such as the ergodic or long run average cost After a general introduction to control problems the book covers the topic dividing into four parts with different dynamical systems control of discrete time deterministic systems discrete time stochastic systems ordinary differential equations and finally a general continuous time MCP with applications for stochastic differential equations The first and second part should be accessible to undergraduate students with some knowledge of elementary calculus linear algebra and some concepts from probability theory random variables expectations and so forth Whereas the third and fourth part would be appropriate for advanced undergraduates or graduate students who have a working knowledge of mathematical analysis derivatives integrals and stochastic processes   Nonlinear and Optimal Control Systems Thomas L. Vincent,Walter J. Grantham,1997-06-23 Designed for one semester introductory senior or graduate level course the authors provide the student with an introduction of analysis techniques used in the design of nonlinear and optimal feedback control systems There is special emphasis on the fundamental topics of stability controllability and optimality and on the corresponding geometry associated with these topics Each chapter contains several examples and a variety of exercises

Introduction To Optimal Control: Bestsellers in 2023 The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous captivating novels captivating the hearts of readers worldwide. Lets delve into the realm of popular books, exploring the fascinating narratives that have enthralled audiences this year. The Must-Read : Colleen Hoovers "It Ends with Us" This poignant tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover expertly weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can prevail. Introduction To Optimal Control : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids compelling storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Discover the Magic : Delia Owens "Where the Crawdads Sing" This evocative coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens weaves a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting. These top-selling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of compelling stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a exceptional and gripping novel that will keep you wondering until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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