



# OPTIMAL CONTROL AND ESTIMATION

Robert F. Stengel

# Optimal Control Theory

**Michael Athans, Peter L. Falb**



## **Optimal Control Theory:**

*Optimal Control Theory* Donald E. Kirk, 2004-01-01 Geared toward upper level undergraduates this text introduces three aspects of optimal control theory dynamic programming Pontryagin's minimum principle and numerical techniques for trajectory optimization Numerous problems which introduce additional topics and illustrate basic concepts appear throughout the text Solution guide available upon request 131 figures 14 tables 1970 edition

*Optimal Control Theory* Suresh P. Sethi, Gerald L. Thompson, 2005-09-06 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 authors have applied to business management problems developed from their research and classroom instruction Sethi and Thompson have provided management science and economics communities with a thoroughly revised edition of their classic text on Optimal Control Theory The new edition has been completely refined with careful attention to the text and graphic material presentation Chapters cover a range of topics including finance production and inventory problems marketing problems machine maintenance and replacement problems of optimal consumption of natural resources and applications of control theory to economics The book contains new results that were not available when the first edition was published as well as an expansion of the material on stochastic optimal control theory

*Optimal Control* Michael Athans, Peter L. Falb, 2007-01-01 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

*Optimal Control Theory* Robert Pallu de La Barrière, 1980

**Introduction to Control Theory, Including Optimal Control** David N. Burghes, Alexander Graham, 1980

*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 *Optimal Control with Aerospace Applications* James M Longuski, José J. Guzmán, John E. Prussing, 2013-11-04 Want to know not just what makes rockets go up but how to do it optimally Optimal control theory has become such an important field in aerospace engineering that no graduate student or practicing engineer can afford to be without a working knowledge of it This is the first book that begins from scratch to teach the reader the basic principles of the calculus of variations develop the necessary conditions step by step and introduce the elementary computational techniques of optimal control This book with problems and an online solution manual provides the graduate level reader with enough introductory knowledge so that he or she can not only read the literature and study the next level textbook but can also apply the theory to find optimal solutions in practice No more is needed than the usual background of an undergraduate engineering science or mathematics program namely calculus differential equations and numerical integration Although finding optimal solutions for these problems is a complex process involving the calculus of variations the authors carefully lay out step by step the most important theorems and concepts Numerous examples are worked to demonstrate how to apply the theories to everything from classical problems e g crossing a river in minimum time to engineering problems e g minimum fuel launch of a satellite Throughout the book use is made of the time optimal launch of a satellite into orbit as an important case study with detailed analysis of two examples launch from the Moon and launch from Earth For launching into the field of optimal solutions look no further Foundations of Optimal Control Theory Ernest Bruce Lee, Lawrence Markus, 1967

Optimal Control Theory , 1967 **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

**Principles of Optimal Control Theory** R. Gamkrelidze, 2014-01-15      *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

*Optimal Control* Frank L. Lewis, Dragana Vrabie, Vassilis L. Syrmos, 2012-03-20 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 Theory and Static Optimization in Economics Daniel Léonard, Ngo van Long, 1992-01-31 Optimal control theory is a technique being used increasingly by academic economists to study problems involving optimal decisions in a multi period framework This textbook is designed to make the difficult subject of optimal control theory easily accessible to economists while at the same time maintaining rigour Economic intuitions are emphasized and examples and problem sets covering a wide range of applications in economics are provided to assist in the learning process Theorems are clearly stated and their proofs are carefully explained The development of the text is gradual and fully

integrated beginning with simple formulations and progressing to advanced topics such as control parameters jumps in state variables and bounded state space For greater economy and elegance optimal control theory is introduced directly without recourse to the calculus of variations The connection with the latter and with dynamic programming is explained in a separate chapter A second purpose of the book is to draw the parallel between optimal control theory and static optimization Chapter 1 provides an extensive treatment of constrained and unconstrained maximization with emphasis on economic insight and applications Starting from basic concepts it derives and explains important results including the envelope theorem and the method of comparative statics This chapter may be used for a course in static optimization The book is largely self contained No previous knowledge of differential equations is required

**Optimal Control Theory for Applications** David G. Hull, 2013-03-09 Mechanical engineering an engineering discipline born of the needs of the industrial revolution is once again asked to do its substantial share in the call for industrial renewal The general call is urgent as we face profound issues of productivity and competitiveness that require engineering solutions among others The Mechanical Engineering Series is a series featuring graduate texts and research monographs intended to address the need for information in contemporary areas of mechanical engineering The series is conceived as a comprehensive one that covers a broad range of concentrations important to mechanical engineering graduate education and research We are fortunate to have a distinguished roster of consulting editors each an expert in one of the areas of concentration The names of the consulting editors are listed on page ii of this volume The areas of concentration are applied mathematics biomechanics computational mechanics dynamic systems and control energetics mechanics of materials processing thermal science and tribology Austin Texas Frederick F Ling Preface Optimization is an area of mathematics that is concerned with finding the best points curves surfaces and so on Best is determined by minimizing some measure of performance subject to equality and inequality constraints Points are constrained by algebraic equations curves are constrained by ordinary differential equations and algebraic equations surfaces are constrained by partial differential equations ordinary differential equations and algebraic equations

**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      **Optimal Control Theory** L.D.

Berkovitz,2013-03-14 This book is an introduction to the mathematical theory of optimal control of processes governed by ordinary differential equations It is intended for students and professionals in mathematics and in areas of application who want a broad yet relatively deep concise and coherent introduction to the subject and to its relationship with applications In order to accommodate a range of mathematical interests and backgrounds among readers the material is arranged so that the more advanced mathematical sections can be omitted without loss of continuity For readers primarily interested in applications a recommended minimum course consists of Chapter I the sections of Chapters II III and IV so recommended in the introductory sections of those chapters and all of Chapter V The introductory section of each chapter should further guide the individual reader toward material that is of interest to him A reader who has had a good course in advanced calculus should be able to understand the definitions and statements of the theorems and should be able to follow a substantial portion of the mathematical development The entire book can be read by someone familiar with the basic aspects of Lebesgue integration and functional analysis For the reader who wishes to find out more about applications we recommend references 2 13 33 35 and 50 of the Bibliography at the end of the book      **Foundations of optimal control theory** ,1976

*Geometric Optimal Control* Heinz Schättler,Urszula Ledzewicz,2012-06-26 This book gives a comprehensive treatment of the fundamental necessary and sufficient conditions for optimality for finite dimensional deterministic optimal control problems The emphasis is on the geometric aspects of the theory and on illustrating how these methods can be used to solve optimal control problems It provides tools and techniques that go well beyond standard procedures and can be used to obtain a full understanding of the global structure of solutions for the underlying problem The text includes a large number and variety of fully worked out examples that range from the classical problem of minimum surfaces of revolution to cancer treatment for novel therapy approaches All these examples in one way or the other illustrate the power of geometric techniques and methods The versatile text contains material on different levels ranging from the introductory and elementary to the advanced Parts of the text can be viewed as a comprehensive textbook for both advanced undergraduate and all level graduate courses on optimal control in both mathematics and engineering departments The text moves smoothly from the

more introductory topics to those parts that are in a monograph style were advanced topics are presented While the presentation is mathematically rigorous it is carried out in a tutorial style that makes the text accessible to a wide audience of researchers and students from various fields including the mathematical sciences and engineering Heinz Sch ttler is an Associate Professor at Washington University in St Louis in the Department of Electrical and Systems Engineering Urszula Ledzewicz is a Distinguished Research Professor at Southern Illinois University Edwardsville in the Department of Mathematics and Statistics

*Optimal Control Theory with Economic Applications* A. Seierstad,K. Sydsæter,1987-02 This book serves not only as an introduction but also as an advanced text and reference source in the field of deterministic optimal control systems governed by ordinary differential equations It also includes an introduction to the classical calculus of variations An important feature of the book is the inclusion of a large number of examples in which the theory is applied to a wide variety of economics problems The presentation of simple models helps illuminate pertinent qualitative and analytic points useful when confronted with a more complex reality These models cover economic growth in both open and closed economies exploitation of non renewable resources pollution control behaviour of firms and differential games A great emphasis on precision pervades the book setting it apart from the bulk of literature in this area The rigorous techniques presented should help the reader avoid errors which often recur in the application of control theory within economics



## Decoding **Optimal Control Theory**: Revealing the Captivating Potential of Verbal Expression

In a time characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its power to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Optimal Control Theory**," a mesmerizing literary creation penned with a celebrated wordsmith, readers attempt an enlightening odyssey, unraveling the intricate significance of language and its enduring affect our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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