An Introduction To Optimal Control Problems In Life Sciences And Economics From Mathematical Models To Numerical Simulation With Matlabi 1 2 Modeling In Science Engineering And Technology

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. Throughout there are many worked examples, and numerous exercises (with solutions) are provided.

Optimal Control TheoryAn IntroductionCourier Corporation
This book showcases a subclass of hereditary systems, that is, systems with behaviour depending not only on their current state but also on their past history; it is an introduction to the mathematical theory of optimal control for stochastic difference Volterra equations of neutral type. As such, it will be of much interest to researchers interested in modelling processes in physics, mechanics, automatic regulation, economics and finance, biology, sociology and medicine for all of which such equations are very popular tools. The text deals with problems of optimal control such as meeting given performance criteria, and stabilization, extending them to neutral stochastic difference Volterra equations. In particular, it contrasts the difference analogues of solutions to optimal control and optimal estimation problems for

stochastic integral Volterra equations with optimal solutions for corresponding problems in stochastic difference Volterra equations. Optimal Control of Stochastic Difference Volterra Equations commences with an historical introduction to the emergence of this type of equation with some additional mathematical preliminaries. It then deals with the necessary conditions for optimality in the control of the equations and constructs a feedback control scheme. The approximation of stochastic quasilinear Volterra equations with quadratic performance functionals is then considered. Optimal stabilization is discussed and the filtering problem formulated. Finally, two methods of solving the optimal control problem for partly observable linear stochastic processes, also with quadratic performance functionals, are developed. Integrating the author's own research within the context of the current state-of-the-art of research in difference equations, hereditary systems theory and optimal control, this book is addressed to specialists in mathematical optimal control theory and to graduate students in pure and applied mathematics and control engineering.

Providing an introduction to stochastic optimal control in infinite dimension, this book gives a complete account of the theory of second-order HJB equations in infinite-dimensional Hilbert spaces, focusing on its applicability to associated stochastic optimal control problems. It features a general introduction to optimal stochastic control, including basic results (e.g. the dynamic programming principle) with proofs, and provides examples of applications. A complete and up-to-date exposition of the existing theory of viscosity solutions and regular solutions of second-order HJB equations in Hilbert spaces is given, together with an extensive survey of other methods, with a full bibliography. In particular, Chapter 6, written by M. Fuhrman and G. Tessitore, surveys the theory of regular solutions of HJB equations arising in

infinite-dimensional stochastic control, via BSDEs. The book is of interest to both pure and applied researchers working in the control theory of stochastic PDEs, and in PDEs in infinite dimension. Readers from other fields who want to learn the basic theory will also find it useful. The prerequisites are: standard functional analysis, the theory of semigroups of operators and its use in the study of PDEs, some knowledge of the dynamic programming approach to stochastic optimal control problems in finite dimension, and the basics of stochastic analysis and stochastic equations in infinite-dimensional spaces. Optimal control is a modern development of the calculus of variations and classical optimization theory. For that reason, this introduction to the theory of optimal control starts by considering the problem of minimizing a function of many variables. It moves through an exposition of the calculus of variations, to the optimal control of systems governed by ordinary differential equations. This approach should enable students to see the essential unity of important areas of mathematics, and also allow optimal control and the Pontryagin maximum principle to be placed in a proper context. A good knowledge of analysis, algebra, and methods is assumed. All the theorems are carefully proved, and there are many worked examples and exercises. Although this book is written for the advanced undergraduate mathematician, engineers and scientists who regularly rely on mathematics will also find it a useful text. Graduate-level text provides introduction to optimal control theory for stochastic systems, emphasizing application of basic concepts to real problems.

This book provides a direct and comprehensive introduction to theoretical and numerical concepts in the emerging field of optimal control of partial differential

equations (PDEs) under uncertainty. The main objective of the book is to offer graduate students and researchers a smooth transition from optimal control of deterministic PDEs to optimal control of random PDEs. Coverage includes uncertainty modelling in control problems, variational formulation of PDEs with random inputs, robust and risk-averse formulations of optimal control problems, existence theory and numerical resolution methods. The exposition focusses on the entire path, starting from uncertainty modelling and ending in the practical implementation of numerical schemes for the numerical approximation of the considered problems. To this end, a selected number of illustrative examples are analysed in detail throughout the book. Computer codes, written in MatLab, are provided for all these examples. This book is adressed to graduate students and researches in Engineering, Physics and Mathematics who are interested in optimal control and optimal design for random partial differential equations. 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.

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

When the Tyrian princess Dido landed on the North African shore of the Mediterranean sea she was welcomed by a local chieftain. He offered her all the land that she could enclose between the shoreline and a rope of knotted cowhide. While the legend does not tell us, we may assume that Princess Dido arrived at the correct solution by stretching the rope into the shape of a circular arc and thereby maximized the area of the land upon which she was to found Carthage. This story of the founding of Carthage is apocryphal. Nonetheless it is probably the first account of a problem of the kind that inspired an entire mathematical discipline, the calculus of variations and its extensions such as the

theory of optimal control. This book is intended to present an introductory treatment of the calculus of variations in Part I and of optimal control theory in Part II. The discussion in Part I is restricted to the simplest problem of the calculus of variations. The topic is entirely classical; all of the basic theory had been developed before the turn of the century. Consequently the material comes from many sources; however, those most useful to me have been the books of Oskar Bolza and of George M. Ewing. Part II is devoted to the elementary aspects of the modern extension of the calculus of variations, the theory of optimal control of dynamical systems.

An Introduction to Applied Optimal Control

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.

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].

This book introduces a variety of problem statements in classical optimal control, in optimal estimation and filtering, and in optimal control problems with non-scalar-valued performance criteria. Many example problems are solved completely in the body of the text. All chapter-end exercises are sketched in the appendix. The theoretical part of the book is based on the calculus of variations, so the exposition is very transparent and requires little mathematical rigor.

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.

This book focuses on maximum principle and verification theorem for incomplete information forward-backward stochastic differential equations (FBSDEs) and their applications in linear-quadratic optimal controls and mathematical finance. ?Lots of interesting phenomena arising from the area of mathematical finance can be described by FBSDEs. Optimal control problems of FBSDEs are theoretically important and practically relevant. A standard assumption in the literature is that the stochastic noises in the model are completely observed. However, this is rarely the case in real world situations. The optimal control problems under complete information are studied extensively. Nevertheless, very little is known about these problems when the information is not complete. The aim of this book is to fill this gap. This book is written in a style suitable for graduate students and researchers in mathematics and engineering with basic knowledge of stochastic process, optimal control and mathematical finance.

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. This book may be regarded as consisting of two parts. In Chapters I-IV we pre sent what we regard as essential topics in an introduction to deterministic optimal control theory. This

material has been used by the authors for one semester graduate-level courses at Brown University and the University of Kentucky. The simplest problem in calculus of variations is taken as the point of departure, in Chapter I. Chapters II, III, and IV deal with necessary conditions for an opti mum, existence and regularity theorems for optimal controls, and the method of dynamic programming. The beginning reader may find it useful first to learn the main results, corollaries, and examples. These tend to be found in the earlier parts of each chapter. We have deliberately postponed some difficult technical proofs to later parts of these chapters. In the second part of the book we give an introduction to stochastic optimal control for Markov diffusion processes. Our treatment follows the dynamic pro gramming method, and depends on the intimate relationship between second order partial differential equations of parabolic type and stochastic differential equations. This relationship is reviewed in Chapter V, which may be read inde pendently of Chapters I-IV. Chapter VI is based to a considerable extent on the authors' work in stochastic control since 1961. It also includes two other topics important for applications, namely, the solution to the stochastic linear regulator and the separation principle.

This book is an introduction to the mathematical theory of optimal control of processes governed by ordinary differential eq- tions. 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 relati- ship with applications. In order to accommodate a range of mathema- cal interests and backgrounds among readers, the material is arranged so that the more advanced mathematical sections can

be omitted wi- out loss of continuity. For readers primarily interested in appli- tions a recommended minimum course consists of Chapter I, the sections of Chapters II, III, and IV so recommended in the introductory sec tions of those chapters, and all of Chapter V. The introductory sec tion 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 defini tions 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 Lebesque 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.

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.

Exploration of stochastic control theory in terms of analysis, parametric optimization, and optimal stochastic control. Limited to linear systems with quadratic criteria; covers discrete time and continuous time systems. 1970 edition.

In the development of optimal control, the complexity of the systems to which it is applied has increased significantly, becoming an issue in scientific computing. In order

to carry out model-reduction on these systems, the authors of this work have developed a method based on asymptotic analysis. Moving from abstract explanations to examples and applications with a focus on structural network problems, they aim at combining techniques of homogenization and approximation. Optimal Control Problems for Partial Differential Equations on Reticulated Domains is an excellent reference tool for graduate students, researchers, and practitioners in mathematics and areas of engineering involving reticulated domains.

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

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.

This is an intuitively motivated presentation of many topics in classical mechanics and related areas of control theory and calculus of variations. All topics throughout the book are treated with zero tolerance for unrevealing definitions and for proofs which leave the reader in the dark. Some areas of particular interest are: an extremely short derivation of the ellipticity of planetary orbits; a statement and an explanation of the "tennis racket paradox"; a heuristic explanation (and a rigorous treatment) of the gyroscopic effect; a revealing equivalence between the dynamics of a particle and statics of a spring; a short geometrical explanation of Pontryagin's Maximum Principle, and more. In the last chapter, aimed at more advanced readers, the Hamiltonian and the momentum are compared to forces in a certain static problem. This gives a palpable physical meaning to some seemingly abstract concepts and theorems. With minimal prerequisites consisting of basic calculus and basic undergraduate physics, this book is suitable for courses from an undergraduate to a beginning graduate level, and for a mixed audience of mathematics, physics and engineering students. Much of the enjoyment of the subject lies in solving almost 200 problems in this book.

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.

A rigorous introduction to optimal control theory, with an emphasis on applications in economics. This book bridges optimal control theory and economics, discussing ordinary differential equations, optimal control, game theory, and mechanism design in one volume. Technically rigorous and largely self-contained, it provides an introduction to the use of optimal control theory for deterministic continuous-time systems in economics. The theory of ordinary differential equations (ODEs) is the backbone of the theory developed in the book, and chapter 2 offers a detailed review of basic concepts in the theory of ODEs, including the solution of systems of linear ODEs, state-space analysis, potential functions, and stability analysis. Following this, the book covers the main results of optimal control theory, in particular necessary and sufficient optimality conditions; game theory, with an emphasis on differential games; and the application of control-theoretic concepts to the design of economic mechanisms. Appendixes provide a mathematical review and full solutions to all end-of-

chapter problems. The material is presented at three levels: single-person decision making; games, in which a group of decision makers interact strategically; and mechanism design, which is concerned with a designer's creation of an environment in which players interact to maximize the designer's objective. The book focuses on applications; the problems are an integral part of the text. It is intended for use as a textbook or reference for graduate students, teachers, and researchers interested in applications of control theory beyond its classical use in economic growth. The book will also appeal to readers interested in a modeling approach to certain practical problems involving dynamic continuous-time models.

Copyright: f1f098e1f9d01bff7dca3ae4ac0abd48