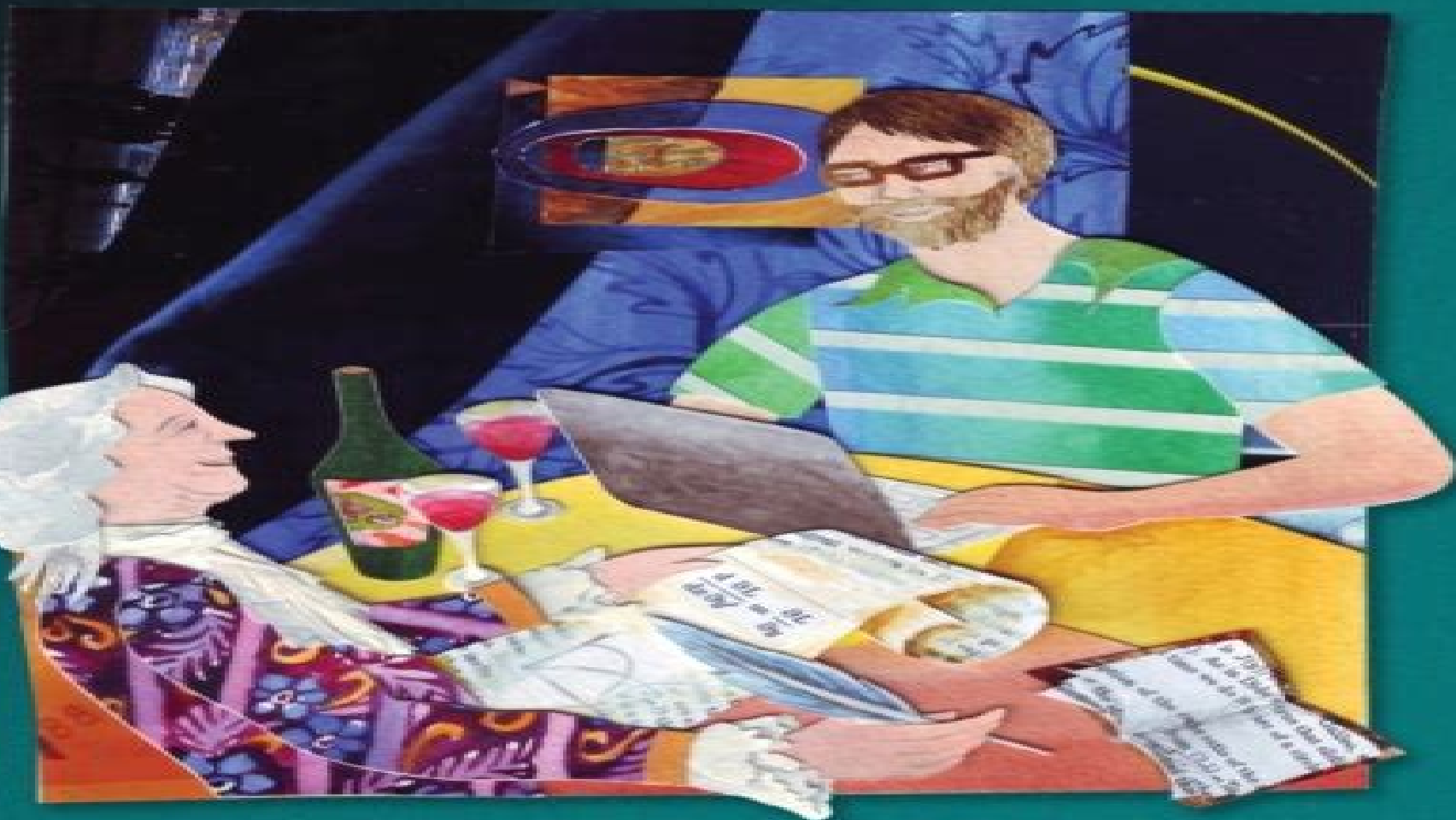


# CALCULUS OF VARIATIONS AND OPTIMAL CONTROL THEORY

A Concise Introduction



DANIEL LIBERZON

# Lectures On The Calculus Of Variations And Optimal Control Theory

**Laurence Chisholm Young**



## **Lectures On The Calculus Of Variations And Optimal Control Theory:**

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may occur He extends the theory of geodesic coverings to optimal control problems Finally he extends the problem to generalized optimal control problems and obtains the corresponding existence theorems *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 Optimal Control Theory Zhongjing Ma, Suli Zou, 2021-01-30 This book focuses on how to implement optimal control problems via the variational method It studies how to implement the extrema of functional by applying the variational method and covers the extrema of functional with different boundary conditions involving multiple functions and with certain constraints etc It gives the necessary and sufficient condition for the continuous time optimal control solution via the variational method solves the optimal control problems with different boundary conditions analyzes the linear quadratic regulator tracking problems respectively in detail and provides the solution of optimal control problems with state constraints by applying the Pontryagin's minimum principle which is developed based upon the calculus of variations And the developed results are applied to implement several classes of popular optimal control problems and say minimum time minimum fuel and minimum energy problems and so on As another key branch of optimal control methods it also presents how to solve the optimal control problems via dynamic programming and discusses the relationship between the variational method and dynamic programming for comparison Concerning the system involving individual agents it is also worth to study how to implement the decentralized solution for the underlying optimal control problems in the framework of differential games The equilibrium is implemented by applying both Pontryagin's minimum principle and dynamic programming The book also analyzes the discrete time version for all the above materials as well since the discrete time optimal control problems are very popular in many fields *A Primer on the Calculus of Variations and Optimal Control Theory* Mike Mesterton-Gibbons, 2009 The calculus of variations is used to find functions that optimize quantities expressed in terms of

integrals Optimal control theory seeks to find functions that minimize cost integrals for systems described by differential equations This book is an introduction to both the classical theory of the calculus of variations and the more modern developments of optimal control theory from the perspective of an applied mathematician It focuses on understanding concepts and how to apply them The range of potential applications is broad the calculus of variations and optimal control theory have been widely used in numerous ways in biology criminology economics engineering finance management science and physics Applications described in this book include cancer chemotherapy navigational control and renewable resource harvesting The prerequisites for the book are modest the standard calculus sequence a first course on ordinary differential equations and some facility with the use of mathematical software It is suitable for an undergraduate or beginning graduate course or for self study It provides excellent preparation for more advanced books and courses on the calculus of variations and optimal control theory

*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

*Optimal Control of Differential Equations* Nicolae H. Pavel, 2020-08-19 Based on the International Conference on Optimal Control of Differential Equations held recently at Ohio University Athens this Festschrift to honor the sixty fifth birthday of Constantin Corduneanu an outstanding researcher in differential and integral equations provides in depth coverage of recent advances applications and open problems relevant to mathematics and physics Introduces new results as well as novel methods and techniques

Fundamental Concepts and Problems of Optimal Control Theory Laurence Chisholm Young, 1970

Global Methods in Optimal Control Theory Vadim Krotov, 1995-10-13 This work describes all basic equations and inequalities that form the necessary and sufficient optimality conditions of variational calculus and the theory of optimal control Subjects addressed include developments in the investigation of optimality conditions new classes of solutions analytical and computation methods and applications

**Applied Optimal Control Theory of Distributed Systems** K.A.

Lurie, 2013-11-21 This book represents an extended and substantially revised version of my earlier book *Optimal Control in Problems of Mathematical Physics* originally published in Russian in 1975 About 60% of the text has been completely revised and major additions have been included which have produced a practically new text My aim was to modernize the presentation but also to preserve the original results some of which are little known to a Western reader The idea of composites which is the core of the modern theory of optimization was initiated in the early seventies The reader will find here its implementation in the problem of optimal conductivity distribution in an MHD generator channel flow Since then it has emerged into an extensive theory which is undergoing a continuous development The book does not pretend to be a textbook neither does it offer a systematic presentation of the theory Rather it reflects a concept which I consider as fundamental in the modern approach to optimization of distributed systems Bibliographical notes though extensive do not pretend to be exhaustive as well My thanks are due to Professor Jean Louis Armand and Professor Wolf Stadler whose friendly assistance in translating and polishing the text was so valuable I am indebted to Mrs Kathleen Durand and Mrs Colleen Lewis for the hard job of typing large portions of the manuscript

### **Introduction to the Calculus of Variations** Hans

Sagan, 2012-04-26 Provides a thorough understanding of calculus of variations and prepares readers for the study of modern optimal control theory Selected variational problems and over 400 exercises Bibliography 1969 edition Evolution Equations, Control Theory, and Biomathematics Philippe Clement, G Lumer, 1993-11-23 Based on the Third International Workshop Conference on Evolution Equations Control Theory and Biomathematics held in Hans sur Lesse Belgium The papers examine important advances in evolution equations related to physical engineering and biological applications

### **NASA Technical Note**, 1971

### **Calculus of Variations II**

Mariano Giaquinta, Stefan Hildebrandt, 2004-06-30 This book by two of the foremost researchers and writers in the field is the first part of a treatise that covers the subject in breadth and depth paying special attention to the historical origins of the theory Both individually and collectively these volumes have already become standard references *Deterministic and Stochastic Optimal Control* Wendell H.

Fleming, Raymond W. Rishel, 2012-12-06 This book may be regarded as consisting of two parts In Chapters I IV we present 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 optimum 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 programming 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 independently 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

*Mathematics Applied to Continuum Mechanics* Lee A. Segel, 2007-07-12 This classic work gives an excellent overview of the subject with an emphasis on clarity explanation and motivation Extensive exercises and a valuable section containing hints and answers make this an excellent text for both classroom use and independent study

**Optimization—Theory and Applications** L. Cesari, 2012-12-06 This book has grown out of lectures and courses in calculus of variations and optimization taught for many years at the University of Michigan to graduate students at various stages of their careers and always to a mixed audience of students in mathematics and engineering It attempts to present a balanced view of the subject giving some emphasis to its connections with the classical theory and to a number of those problems of economics and engineering which have motivated so many of the present developments as well as presenting aspects of the current theory particularly value theory and existence theorems However the presentation of the theory is connected to and accompanied by many concrete problems of optimization classical and modern some more technical and some less so some discussed in detail and some only sketched or proposed as exercises No single part of the subject such as the existence theorems or the more traditional approach based on necessary conditions and on sufficient conditions or the more recent one based on value function theory can give a sufficient representation of the whole subject This holds particularly for the existence theorems some of which have been conceived to apply to certain large classes of problems of optimization For all these reasons it is essential to present many examples Chapters 3 and 6 before the existence theorems Chapters 9 and 11 16 and to investigate these examples by means of the usual necessary conditions sufficient conditions and value function theory

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