Geometrical Methods In The Theory Of Ordinary Differential Equations Grundlehren Der Mathematischen Wissenschaften V 250

Both mathematics and mathematical physics have many active areas of research where the interplay between geometry and quantum field theory has proved extremely fruitful. Duality, gauge field theory, geometric quantization, SeibergOCoWitten theory, spectral properties and families of Dirac operators, and the geometry of loop groups offer some striking recent examples of modern topics which stand on the borderline between geometry and analysis on the one hand and quantum field theory on the other, where the physicist''s and the mathematician''s perspective complement each other, leading to new mathematical and physical concepts and results. This volume introduces the reader to some basic mathematical and physical tools and methods required to follow the recent developments in some active areas of mathematical physics, including duality, gauge field theory, geometric quantization, Seiberg-Witten theory, spectral properties and families of Dirac operators, and the geometry of loop groups. It comprises seven self-contained lectures, which should progressively give the reader a precise idea of some of the techniques used in these areas, as well as a few short communications presented by young participants at the school. Contents: Lectures: Introduction to Differentiable Manifolds and Symplectic Geometry (T Wurzbacher); Spectral Properties of the Dirac Operator and Geometrical Structures (O Hijazi); Quantum Theory of Fermion Systems: Topics Between Physics and Mathematics (E Langmann); Heat Equation and Spectral Geometry. Introduction for Beginners (K Wojciechowski); Renormalized Traces as a Geometric Tool (S Paycha); Concepts in Gauge Theory Leading to Electric-Magnetic Duality (T S Tsun); An Introduction to Seiberg-Witten Theory (H Ocampo); Short Communications: Remarks on Duality, Analytical Torsion and Gaussian Integration in Antisymmetric Field Theories (A Cardona); Multiplicative Anomaly for the e-Regularized Determinant (C Ducourtioux); On Cohomogeneity One Riemannian Manifolds (S M B Kashani); A Differentiable Calculus on the Space of Loops and Connections (M Reiris); Quantum Hall Conductivity and Topological Invariants (A Reyes); Determinant of the Dirac Operator Over the Interval [0,] (F Torres-Ardila). Readership: Mathematicians and physicists."

The book introduces conceptually simple geometric ideas based on the existence of fundamental domains for metric G- spaces. A list of the problems discussed includes Borsuk-Ulam type theorems for degrees of equivariant maps in finite and infinite dimensional cases, extensions of equivariant maps and equivariant homotopy classification, genus and G-category, elliptic boundary value problem, equivalence of p-group representations. The new results and geometric clarification of several known theorems presented here will make it interesting and useful for specialists in equivariant topology and its applications to non-linear analysis and representation theory.

From the reviews: "In this Lecture Note volume the author describes his differential-geometric approach to parametrical statistical problems summarizing the results he had published in a series of papers in the last five years. The author provides a geometric framework for a special class of test and estimation procedures for curved exponential families. ... ... The material and ideas presented in this volume are important and it is recommended to everybody interested in the connection between statistics and geometry ..." #Metrika#1 "More than hundred references are given showing the growing interest in differential geometry with respect to statistics. The book can only strongly be recommended to a geodesist since it offers many new insights into statistics on a familiar ground." #Manuscripta Geodaetica#2

This book brings together geometric tools and their applications for Information analysis. It collects current and many uses of in the interdisciplinary fields of Information Geometry Manifolds in Advanced Signal, Image & Video Processing, Complex Data Modeling and Analysis, Information Ranking and Retrieval, Coding, Cognitive Systems, Optimal Control, Statistics on Manifolds, Machine Learning, Speech/sound recognition and natural language treatment which are also substantially relevant for the industry.

Information geometry provides the mathematical sciences with a new framework of analysis. It has emerged from the investigation of the natural differential geometric structure on manifolds of probability distributions, which consists of a Riemannian metric defined by the Fisher information and a one-parameter family of affine connections called the α-connections. The duality between the α-connection and the $(-\alpha)$-connection together with the metric play an essential role in this geometry. This kind of duality, having emerged from manifolds of probability distributions, is ubiquitous, appearing in a variety of problems which might have no explicit relation to probability theory. Through the duality, it is possible to analyze various fundamental problems in a unified perspective. The first half of this book is devoted to a comprehensive introduction to the mathematical foundation of information geometry, including preliminaries from differential geometry, the geometry of manifolds or probability distributions, and the general theory of dual affine connections. The second half of the text provides an overview of many areas of applications, such as statistics, linear systems, information theory, quantum mechanics, convex analysis, neural networks, and affine differential geometry. The book can serve as a suitable text for a topics course for advanced undergraduates and graduate students.

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 Schättler 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.

Aimed at graduate students in physics and mathematics, this book provides an introduction to recent developments in several active topics at the interface between algebra, geometry, topology and quantum field theory. The first part of the book begins with an account of important results in geometric topology. It investigates the differential equation aspects of quantum cohomology, before moving on to noncommutative geometry. This is followed by a further exploration of quantum field theory and gauge theory, describing AdS/CFT correspondence, and the functional renormalization group approach to quantum gravity. The second part covers a wide spectrum of topics on the borderline of mathematics and physics, ranging from orbifolds to quantum indistinguishability and involving a manifold of mathematical tools borrowed from geometry, algebra and analysis. Each chapter presents introductory material before moving on to more advanced results. The chapters are self-contained and can be read independently of the rest.

For physicists and applied mathematicians working in the fields of relativity and cosmology, high-energy physics and field theory, thermodynamics, fluid dynamics and mechanics. This book provides an introduction to the concepts and techniques of modern differential theory, particularly Lie groups, Lie forms and differential forms.

Since the first edition of this book, geometrical methods in the theory of ordinary differential equations have become very popular and some progress has been made partly with the help of computers. Much of this progress is represented in this revised, expanded edition, including such topics as the Feigenbaum universality of period doubling, the Zoladec solution, the Iljashenko proof, the Ecalle and Voronin theory, the Varchenko and Hovanski theorems, and the Neistadt theory. In the selection of material for this book, the author explains basic ideas and methods applicable to the study of differential equations. Special efforts were made to keep the basic ideas free from excessive technicalities. Thus the most fundamental questions are considered in great detail, while of the more special and difficult parts of the theory have the character of a survey. Consequently, the reader needs only a general mathematical knowledge to easily follow this text. It is directed to mathematicians, as well as all users of the theory of differential equations.

Geometric Methods in System Theory In automatic control there are a large number of applications of a fairly simple type for which the motion of the state variables is not free to evolve in a vector space but rather must satisfy some constraints. Examples are numerous; in a switched, lossless electrical network energy is conserved and the state evolves on an ellipsoid surface defined by x'Qx equals a constant; in the control of finite state, continuous time, Markov processes the state evolves on the set x'x = 1, xi ~ O. The control of rigid body motions and trajectory control leads to problems of this type. There has been under way now for some time an effort to build up enough control theory to enable one to treat these problems in a more or less routine way. It is important to emphasise that the ordinary vector space-linear theory often gives the wrong insight and thus should not be relied upon.

Geometric Measure Theory: A Beginner's Guide provides information pertinent to the development of geometric measure theory. This book presents a few fundamental arguments and a superficial discussion of the regularity theory. Organized into 12 chapters, this book begins with an overview of the purpose and fundamental concepts of geometric measure theory. This text then provides the measure-theoretic foundation, including the definition of Hausdorff measure and covering theory. Other chapters consider the m-dimensional surfaces of geometric measure theory called rectifiable sets and introduce the two basic tools of the regularity theory of area-minimizing surfaces. This book discusses as well the fundamental theorem of geometric measure theory, which guarantees solutions to a wide class of variational problems in general dimensions. The final chapter deals with the basic methods of geometry and analysis in a generality that embraces manifold applications. This book is a valuable resource for graduate students, mathematicians, and research workers.

VII Preface In many fields of mathematics, geometry has established itself as a fruitful method and common language for describing basic phenomena and problems as well as suggesting ways of solutions. Especially in pure mathematics this is ob vious and well-known (examples are the much discussed interplay between lin ear algebra and analytical geometry and several problems in multidimensional analysis). On the other hand, many specialists from applied mathematics seem to prefer more formal analytical and numerical methods and representations. Nevertheless, very often the internal development of disciplines from applied mathematics led to geometric models, and occasionally breakthroughs were b~ed on geometric insights. An excellent example is the Klee-Minty cube, solving a problem of linear programming by transforming it into a geomet ric problem. Also the development of convex programming in recent decades demonstrated the power of methods that evolved within the field of convex geometry. The present book focuses on three applied disciplines: control theory, location science and computational geometry. It is our aim to demonstrate how methods and topics from convex geometry in a wider sense (separation theory of convex cones, Minkowski geometry, convex partitionings, etc.) can help to solve various problems from these disciplines.

Approach your problems from the right end It isn't that they can't see the solution. It is and begin with the answers. Then one day, that they can't see the problem. perhaps you will find the final question. G. K. Chesterton. The Scandal of Father 'The Hermit Clad in Crane Feathers' in R. Brown 'The point"of a Pin'. van GuIik's The Chinese Maze Murders. Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics. However, the "tree" of knowledge of mathematics and related fields does not grow only by putting forth new branches. It also happens, quite often in fact, that branches which were thought to be completely disparate are suddenly seen to be related. Further, the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years: measure theory is used (non trivially) in regional and theoretical economics; algebraic geometry interacts with physics; ihe Minkowsky lemma, coding theory and the structure of water meet one another in packing and covering theory; quantum fields, crystal defects and mathematical programming profit from homotopy theory; Lie algebras ·are relevant to filtering; and prediction and electrical engineering can use Stein spaces. And in addition to this there are such new emerging subdisciplines as "experimental mathematics", "CFD", "completely integrable systems", "chaos, synergetics and large-scale order", which are almost impossible to fit into the existing classification schemes. They draw upon widely different sections of mathematics.

The main aim of this book is to introduce Lie groups and allied algebraic and geometric concepts to a robotics audience. These topics seem to be quite fashionable at the moment, but most of the robotics books that touch on these topics tend to treat Lie groups as little more than a fancy notation. I hope to show the power and elegance of these methods as they apply to problems in robotics. A subsidiary aim of the book is to reintroduce some old ideas by describing them in modem notation, particularly Study's Quadric-a description of the group of rigid motions in three dimensions as an algebraic variety (well, actually an open subset in an algebraic variety)-as well as some of the less well known aspects of Ball's theory of screws. In the first four chapters, a careful exposition of the theory of Lie groups and their Lie algebras is given. Except for the simplest examples, all examples used to illustrate these ideas are taken from robotics. So, unlike most standard texts on Lie groups, emphasis is placed on a group that is not semi-simple-the group of proper Euclidean motions in three dimensions. In particular, the continuous subgroups of this group are found, and the elements of its Lie algebra are identified with the surfaces of the lower Reuleaux pairs. These surfaces were first identified by Reuleaux in the latter half of the 19th century.

... cette etude qualitative (des equations difj'erentielles) aura par elle-m me un inter t du premier ordre ... HENRI POINCARE, 1881. We present in this book a view of the Geometric Theory of Dynamical Systems, which is introductory and yet gives the reader an understanding of some of the basic ideas involved in two important topics: structural stability and genericity. This theory has been considered by many mathematicians starting with Poincare, Liapunov and Birkhoff. In recent years some of its general aims were established and it experienced considerable development. More than two decades passed between two important events: the work of Andronov and Pontryagin (1937) introducing the basic concept of structural stability and the articles of Peixoto (1958-1962) proving the density of stable vector fields on surfaces. It was then that Smale enriched the theory substantially by defining as a main objective the search for generic and stable properties and by obtaining results and proposing problems of great relevance in this context. In this same period Hartman and Grobman showed that local stability is a generic property. Soon after this Kupka and Smale successfully attacked the problem for periodic orbits. We intend to give the reader the flavour of this theory by means of many examples and by the systematic proof of the Hartman-Grobman and the Stable Manifold Theorems (Chapter 2), the Kupka-Smale Theorem (Chapter 3) and Peixoto's Theorem (Chapter 4). Several ofthe proofs we give vii Introduction Vlll are simpler than the original ones and are open to important generalizations.

Geometrical (in particular, topological) methods in nonlinear analysis were originally invented by Banach, Birkhoff, Kellogg, Schauder, Leray, and others in existence proofs. Since about the fifties, these methods turned out to be essentially the sole approach to a variety of new problems: the investigation of iteration processes and other procedures in numerical analysis, in bifur cation problems and branching of solutions, estimates on the number of solutions and criteria for the existence of nonzero solutions, the analysis of the structure of the solution set, etc. These methods have been widely applied to the theory of forced vibrations and auto-oscillations, to various problems in the theory of elasticity and fluid. mechanics, to control theory, theoretical physics, and various parts of mathematics. At present, nonlinear analysis along with its geometrical, topological, analytical, variational, and other methods is developing tremendously thanks to research work in many countries. Totally new ideas have been advanced, difficult problems have been solved, and new applications have been indicated. To enumerate the publications of the last few years one would need dozens of pages. On the other hand, many problems of non linear analysis are still far from a solution (problems arising from the internal development of mathematics and, in particular, problems arising in the process of interpreting new problems in the natural sciences). We hope that the English edition of our book will contribute to the further propagation of the ideas of nonlinear analysis.

Half a century ago, S. Chandrasekhar wrote these words in the preface to his 1 celebrated and successful book: In this monograph an attempt has been made to present the theory of stellar dy namics as a branch of classical dynamics - a discipline in the same general category as celestial mechanics. [...] Indeed, several of the problems of modern stellar dy namical theory are so severely classical that it is difficult to believe that they are not already discussed, for example, in Jacobi's Vorlesungen. Since then, stellar dynamics has developed in several directions and at var ious levels, basically three viewpoints remaining from which to look at the problems encountered in the interpretation of the phenomenology. Roughly speaking, we can say that a stellar system (cluster, galaxy, etc.) can be con sidered from the point of view of celestial mechanics (the N-body problem with N» 1), fluid mechanics (the system is represented by a material con tinuum), or statistical mechanics (one defines a distribution function for the positions and the states of motion of the components of the system).

* Contains a selection of articles exploring geometric approaches to problems in algebra, algebraic geometry and number theory * The collection gives a representative sample of problems and most recent results in algebraic and arithmetic geometry * Text can serve as an intense introduction for graduate students and those wishing to pursue research in algebraic and arithmetic geometry

Proceedings of the NATO Advanced Research Workshop and the 16th International Conference, Como, Italy, August 24-29, 1987

Over the past fifteen years, the geometrical and topological methods of the theory of manifolds have as- sumed a central role in the most advanced areas of pure and applied mathematics as well as theoretical physics. The three volumes of Modern Geometry - Methods and Applications contain a concrete exposition of these methods together with their main applications in mathematics and physics. This third volume, presented in highly accessible languages, concentrates in homology theory. It contains introductions to the contemporary methods for the calculation of homology groups and the classification of manifesto. Both scientists and students of mathematics as well as theoretical physics will find this book to be a valuable reference and text.

Up until recently, Riemannian geometry and basic topology were not included, even by departments or faculties of mathematics, as compulsory subjects in a university-level mathematical education. The standard courses in the classical differential geometry of curves and surfaces which were given instead (and still are given in some places) have come gradually to be viewed as anachronisms. However, there has been hitherto no unanimous agreement as to exactly how such courses should be brought up to date, that is to say, which parts of modern geometry should be regarded as absolutely essential to a modern mathematical education, and what might be the appropriate level of abstractness of their exposition. The task of designing a modernized course in geometry was begun in 1971 in the mechanics division of the Faculty of Mechanics and Mathematics of Moscow State University. The subject-matter and level of abstractness of its exposition were dictated by the view that, in addition to the geometry of curves and surfaces, the following topics are certainly useful in the various areas of application of mathematics (especially in elasticity and relativity, to name but two), and are therefore essential: the theory of tensors (including covariant differentiation of them); Riemannian curvature; geodesics and the calculus of variations (including the conservation laws and Hamiltonian formalism); the particular case of skew-symmetric tensors (i. e.

The lectures contained in this book were presented at Harvard University in June 1979. The workshop at which they were presented was the third such on algebro-geometric methods. The first was held in 1973 in London and the emphasis was largely on geometric methods. The second was held at Ames Research Center-NASA in 1976. There again the emphasis was on geometric methods, but algebraic geometry was becoming a dominant theme. In the two years after the Ames meeting there was tremendous growth in the applications of algebraic geometry to systems theory and it was becoming clear that much of the algebraic systems theory was very closely related to the geometric systems theory. On this basis we felt that this was the right time to devote a workshop to the applications of algebra and algebraic geometry to linear systems theory. The lectures contained in this volume represent all but one of the tutorial lectures presented at the workshop. The lec ture of Professor Murray Wonham is not contained in this volume and we refer the interested to the archival literature. This workshop was jointly sponsored by a grant from Ames Research Center-NASA and a grant from the Advanced Study Institute Program of NATO. We greatly appreciate the financial support rendered by these two organizations. The American Mathematical Society hosted this meeting as part of their Summer Seminars in Applied Mathematics and will publish the companion volume of con tributed papers.

The expanded second edition of this book reflects new developments including the Feigenbaum universality of period doubling, the Zoladec solution, the Iljashenko proof, the Ecalle and Voronin theory, the Varchenko and Hovanski theorems and the Neistadt theory.

In recent years the methods of modern differential geometry have become of considerable importance in theoretical physics and have found application in relativity and cosmology, high-energy physics and field theory, thermodynamics, fluid dynamics and mechanics. This textbook provides an introduction to these methods - in particular Lie derivatives, Lie groups and differential forms - and covers their extensive applications to theoretical physics. The reader is assumed to have some familiarity with advanced calculus, linear algebra and a little elementary operator theory. The advanced physics undergraduate should therefore find the presentation quite accessible. This account will prove valuable for those with backgrounds in physics and applied mathematics who desire an introduction to the subject. Having studied the book, the reader will be able to comprehend research papers that use this mathematics and follow more advanced pure-mathematical expositions.

As an introduction to fundamental geometric concepts and tools needed for solving problems of a geometric nature using a computer, this book fills the gap between standard geometry books, which are primarily theoretical, and applied books on computer graphics, computer vision, or robotics that do not cover the underlying geometric concepts in detail. Gallier offers an introduction to affine, projective, computational, and Euclidean geometry, basics of differential geometry and Lie groups, and explores many of the practical applications of geometry. Some of these include computer vision, efficient communication, error correcting codes, cryptography, motion interpolation, and robot kinematics. This comprehensive text covers most of the geometric background needed for conducting research in computer graphics, geometric modeling, computer vision, and robotics and as such will be of interest to a wide audience including computer scientists, mathematicians, and engineers.

From the reviews of the second edition: "The new methods of complex manifold theory are very useful tools for investigations in algebraic geometry, complex function theory, differential operators and so on. The differential geometrical methods of this theory were developed essentially under the influence of Professor S.-S. Chern's works. The present book is a second edition... It can serve as an introduction to, and a survey of, this theory and is based on the author's lectures held at the University of California and at a summer seminar of the Canadian Mathematical Congress.... The text is illustrated by many examples... The book is warmly recommended to everyone interested in complex differential geometry." #Acta Scientiarum Mathematicarum, 41, 3-4#

This book details the ideas underlying geometrical theory of diffraction (GTD) along with its relationships with other EM theories.

Full and authoritative, this history of the techniques for dealing with geometric questions begins with synthetic geometry and its origins in Babylonian and Egyptian mathematics; reviews the contributions of China, Japan, India, and Greece; and discusses the non-Euclidean geometries. Subsequent sections cover algebraic geometry, starting with the precursors and advancing to the great awakening with Descartes; and differential geometry, from the early work of Huygens and Newton to projective and absolute differential geometry. The author's emphasis on proofs and notations, his comparisons between older and newer methods, and his references to over 600 primary and secondary sources make this book an invaluable reference. 1940 edition.

This volume contains the proceedings of the CRM Workshops on Probabilistic Methods in Spectral Geometry and PDE, held from August 22–26, 2016 and Probabilistic Methods in Topology, held from November 14–18, 2016 at the Centre de Recherches Mathématiques, Université de Montréal, Montréal, Quebec, Canada. Probabilistic methods have played an increasingly important role in many areas of mathematics, from the study of random groups and random simplicial complexes in topology, to the theory of random Schrödinger operators in mathematical physics. The workshop on Probabilistic Methods in Spectral Geometry and PDE brought together some of the leading researchers in quantum chaos, semi-classical theory, ergodic theory and dynamical systems, partial differential equations, probability, random matrix theory, mathematical physics, conformal field theory, and random graph theory. Its emphasis was on the use of ideas and methods from probability in different areas, such as quantum chaos (study of spectra and eigenstates of chaotic systems at high energy); geometry of random metrics and related problems in quantum gravity; solutions of partial differential equations with random initial conditions. The workshop Probabilistic Methods in Topology brought together researchers working on random simplicial complexes and geometry of spaces of triangulations (with connections to manifold learning); topological statistics, and geometric probability; theory of random groups and their properties; random knots; and other problems. This volume covers recent developments in several active research areas at the interface of Probability, Semiclassical Analysis, Mathematical Physics, Theory of Automorphic Forms and Graph Theory.

This book contains a comprehensive description of the mechanical equilibrium and deformation of membranes as a surface problem in differential geometry. Following the pioneering work by W Helfrich, the fluid membrane is seen as a nematic or smectic ? A liquid crystal film and its elastic energy form is deduced exactly from the curvature elastic theory of the liquid crystals. With surface variation the minimization of the energy at fixed osmotical pressure and surface tension gives a completely new surface equation in geometry that involves potential interest in mathematics. The investigations of the rigorous solution of the equation that have been carried out in recent years by the authors and their co-workers are presented here, among which the torus and the discocyte (the normal shape of the human red blood cell) may attract attention in cell biology. Within the framework of our mathematical model by analogy with cholesteric liquid crystals, an extensive investigation is made of the formation of the helical structures in a tilted chiral lipid bilayer, which has now become a hot topic in the fields of soft matter and biomembranes.

After several decades of reduced contact, the interaction between physicists and mathematicians in the front-line research of both fields recently became deep and fruit ful again. Many of the leading specialists of both fields became involved in this devel opment. This process even led to the discovery of previously unsuspected connections between various subfields of physics and mathematics. In mathematics this concerns in particular knots von Neumann algebras, Kac-Moody algebras, integrable non-linear partial differential equations, and differential geometry in low dimensions, most im portantly in three and four dimensional spaces. In physics it concerns gravity, string theory, integrable classical and quantum field theories, solitons and the statistical me chanics of surfaces. New discoveries in these fields are made at a rapid pace. This conference brought together active researchers in these areas, reporting their results and discussing with other participants to further develop thoughts in future new directions. The conference was attended by SO participants from 15 nations. These proceedings document the program and the talks at the conference. This conference was preceded by a two-week summer school. Ten lecturers gave extended lectures on related topics. The proceedings of the school will also be published in the NATO-AS[volume by Plenum. The Editors vii

ACKNOWLEDGMENTS We would like to thank the many people who have made the conference a success. Furthermore, ·we appreciate the excellent talks. The active participation of everyone present made the conference lively and stimulating. All of this made our efforts worth while.

Geometrical Theory of Diffraction for Electromagnetic Waves

This book presents some facts and methods of the Mathematical Control Theory treated from the geometric point of view. The book is mainly based on graduate courses given by the first coauthor in the years 2000-2001 at the International School for Advanced Studies, Trieste, Italy. Mathematical prerequisites are reduced to standard courses of Analysis and Linear Algebra plus some basic Real and Functional Analysis. No preliminary knowledge of Control Theory or Differential Geometry is required. What this book is about? The classical deterministic physical world is described by smooth dynamical systems: the future in such a system is com pletely determined by the initial conditions. Moreover, the near future changes smoothly with the initial data. If we leave room for "free will" in this fatalistic world, then we come to control systems. We do so by allowing certain param eters of the dynamical system to change freely at every instant of time. That is what we routinely do in real life with our body, car, cooker, as well as with aircraft, technological processes etc. We try to control all these dynamical systems! Smooth dynamical systems are governed by differential equations. In this book we deal only with finite dimensional systems: they are governed by ordi nary differential equations on finite dimensional smooth manifolds. A control system for us is thus a family of ordinary differential equations. The family is parametrized by control parameters.

Few books on Ordinary Differential Equations (ODEs) have the elegant geometric insight of this one, which puts emphasis on the qualitative and geometric properties of ODEs and their solutions, rather than on routine presentation of algorithms. From the reviews: "Professor Arnold has expanded his classic book to include new material on exponential growth, predator-prey, the pendulum, impulse response, symmetry groups and group actions, perturbation and bifurcation." --SIAM REVIEW

In many applications of graph theory, graphs are regarded as geometric objects drawn in the plane or in some other surface. The traditional methods of "abstract" graph theory are often incapable of providing satisfactory answers to questions arising in such applications. In the past couple of decades, many powerful new combinatorial and topological techniques have been developed to tackle these problems. Today geometric graph theory is a burgeoning field with many striking results and appealing open questions. This contributed volume contains thirty original survey and research papers on important recent developments in geometric graph theory. The contributions were thoroughly reviewed and written by excellent researchers in this field.

An up-to-date account of algebraic statistics and information geometry, which also explores the emerging connections between these two disciplines.