Linear Algebra A Geometric Approach Solutions Manual

This book originated from a Discussion Group (Teaching Linear Algebra) that was held at the 13th International Conference on Mathematics Education (ICME-13). The aim was to consider and highlight current efforts regarding research and instruction on teaching and learning linear algebra from around the world, and to spark new collaborations. As the outcome of the two-day discussion at ICME-13, this book focuses on the pedagogy of linear algebra with a particular emphasis on tasks that are productive for learning. The main themes addressed include: theoretical perspectives on the teaching and learning of linear algebra; empirical analyses related to learning particular content in linear algebra; the use of technology and dynamic geometry software; and pedagogical discussions of challenging linear algebra tasks. Drawing on the expertise of mathematics education researchers and research mathematicians with experience in teaching linear algebra, this book gathers work from nine countries: Austria, Germany, Israel, Ireland, Mexico, Slovenia, Turkey, the USA and Zimbabwe.

Through many examples and real-world applications, Practical Linear Algebra: A Geometry Toolbox, Third Edition teaches undergraduate-level linear algebra in a comprehensive, geometric, and algorithmic way. Designed for a one-semester linear algebra course at the undergraduate level, the book gives instructors the option of tailoring the course for the primary interests: math, engineering, science, computer graphics, and geometric modeling. New to the Third Edition More exercises and applications Coverage of singular value decomposition and its application to the pseudoinverse, principal components analysis, and image compression More attention to eigen-analysis, including eigenfunctions and the Google matrix Greater emphasis on orthogonal projections and matrix decompositions, which are tied to repeated themes such as the concept of least squares To help students better visualize and understand the material, the authors introduce the fundamental concepts of linear algebra first in a two-dimensional setting and then revisit these concepts and others in a three-dimensional setting. They also discuss higher dimensions in various real-life applications. Triangles, polygons, conics, and curves are introduced as central applications of linear algebra. Instead of using the standard theorem-proof approach, the text presents many examples and instructional illustrations to help students develop a robust, intuitive understanding of the underlying concepts. The authors' website also offers the illustrations for download and includes Mathematica® code and other ancillary materials.

This unique text provides a geometric approach to group theory and linear algebra, bringing to light the interesting ways in which these subjects interact. Requiring few prerequisites beyond understanding the notion of a proof, the text aims to give students a strong foundation in both geometry and algebra. Starting with preliminaries (relations, elementary combinatorics, and induction), the book then proceeds to the core topics: the elements of the theory of groups and fields (Lagrange's Theorem, cosets, the complex numbers and the prime fields), matrix theory and matrix groups, determinants, vector spaces, linear mappings, eigentheory and diagonalization, Jordan decomposition and normal form, normal matrices, and quadratic forms. The final two chapters consist of a more intensive look at group theory, emphasizing orbit stabilizer methods, and an introduction to linear algebraic groups, which enriches the notion of a matrix group. Applications involving symm etry groups, determinants, linear coding theory and cryptography are interwoven throughout. Each section ends with ample practice problems assisting the reader to better understand the material. Some of the applications are illustrated in the chapter appendices. The author's unique melding of topics evolved from a two semester course that he taught at the University of British Columbia consisting of an undergraduate honors course on abstract linear algebra and a similar course on the theory of groups. The combined content from both makes this rare text ideal for a year-long course, covering more material than most linear algebra texts. It is also optimal for independent study and as a supplementary text for various professional applications. Advanced undergraduate or graduate students in mathematics, physics, computer science and engineering will find this book both useful and enjoyable.

This text presents differential forms from a geometric perspective accessible at the undergraduate level. It begins with basic concepts such as partial differentiation and multiple integration and gently develops the entire machinery of differential forms. The subject is approached with the idea that complex concepts can be built up by analogy from simpler cases, which, being inherently geometric, often can be best understood visually. Each new concept is presented with a natural picture that students can easily grasp. Algebraic properties then follow. The book contains excellent motivation, numerous illustrations and solutions to selected problems.

In wntmg this monograph my aim has been to present a "geometric" approach to the structural synthesis of multivariable control systems that are linear, time-invariant and of finite dynamic order. The book is ad dressed to graduate students specializing in control, to engineering scientists involved in control systems research and development, and to mathemati cians interested in systems control theory. The label "geometric" in the title is applied for several reasons. First and obviously, the setting is linear state space and the mathematics chiefly linear algebra in abstract (geometric) style. The basic ideas are the familiar system concepts of controllability and observability, thought of as geometric prop erties of distinguished state subspaces. Indeed, the geometry was first brought in out of revulsion against the orgy of matrix manipulation which linear control theory mainly consisted of, around fifteen years ago. But secondly and of greater interest, the geometric setting rather quickly sug gested new methods of attacking synthesis which have proved to be intuitive and economical; they are also easily reduced to matrix arithmetic as soon as you want to compute. The essence of the "geometric" approach is just this: instead of looking directly for a feedback law (say u = Fx) which would solve your synthesis problem if a solution exists, first characterize solvability as a verifiable property of some constructible state subspace, say Y. Then, if all is well, you may calculate F from Y quite easily.

This clear, concise and highly readable text is designed for a first course in linear algebra and is intended for undergraduate courses in mathematics. It focusses throughout on geometric explanations to make the student perceive

that linear algebra is nothing but analytic geometry of n dimensions. From the very start, linear algebra is presented as an extension of the theory of simultaneous linear equations and their geometric interpretation is shown to be a recurring theme of the subject. The integration of abstract algebraic concepts with the underlying geometric notions is one of the most distinguishing features of this book — designed to help students in the pursuit of multivariable calculus and differential geometry in subsequent courses.Explanations and concepts are logically presented in a conversational tone and well-constructed writing style so that students at a variety of levels can understand the material and acquire a solid foundation in the basic skills of linear algebra.

Advances in science and technology necessitate the use of increasingly-complicated dynamic control processes. Undoubtedly, sophisticated mathematical models are also concurrently elaborated for these processes. In particular, linear dynamic control systems iJ = Ay + Bu, y E M C]Rn, U E]RT, (1) where A and B are constants, are often abandoned in favor of nonlinear dynamic control systems (2) which, in addition, contain a large number of equations. The solution of problems for multidimensional nonlinear control systems en counters serious difficulties, which are both mathematical and technical in nature. Therefore it is imperative to develop methods of reduction of nonlinear systems to a simpler form, for example, decomposition into systems of lesser dimension. Approaches to reduction are diverse, in particular, techniques based on approxi mation methods. In this monograph, we elaborate the most natural and obvious (in our opinion) approach, which is essentially inherent in any theory of math ematical entities, for instance, in the theory of linear spaces, theory of groups, etc. Reduction in our interpretation is based on assigning to the initial object an isomorphic object, a quotient object, and a subobject. In the theory of linear spaces, for instance, reduction consists in reducing to an isomorphic linear space, quotient space, and subspace. Strictly speaking, the exposition of any mathemat ical theory essentially begins with the introduction of these reduced objects and determination of their basic properties in relation to the initial object.

This monograph is aiming at researchers of systems control, especially those interested in multiagent systems, distributed and decentralized control, and structured systems. The book assumes no prior background in geometric control theory; however, a first year graduate course in linear control systems is desirable. Since not all control researchers today are exposed to geometric control theory, the book also adopts a tutorial style by way of examples that illustrate the geometric and abstract algebra concepts used in linear geometric control. In addition, the matrix calculations required for the studied control synthesis problems of linear multivariable control are illustrated via a set of running design examples. As such, some of the design examples are of higher dimension than one may typically see in a text; this is so that all the geometric features of the design problem are illuminated. Until recently, almost all of the interactions between objects in virtual 3D worlds have been based on calculations performed using linear algebra. Linear algebra relies heavily on coordinates, however, which can make many geometric programming tasks very specific and complex-often a lot of effort is required to bring about even modest performance enhancements. Although linear algebra is an efficient way to specify low-level computations, it is not a suitable high-level language for geometric programming. Geometric Algebra for Computer Science presents a compelling alternative to the limitations of linear algebra. Geometric algebra, or GA, is a compact, time-effective, and performance-enhancing way to represent the geometry of 3D objects in computer programs. In this book you will find an introduction to GA that will give you a strong grasp of its relationship to linear algebra and its significance for your work. You will learn how to use GA to represent objects and perform geometric operations on them. And you will begin mastering proven techniques for making GA an integral part of your applications in a way that simplifies your code without slowing it down. * The first book on Geometric Algebra for programmers in computer graphics and entertainment computing * Written by leaders in the field providing essential information on this new technique for 3D graphics * This full colour book includes a website with GAViewer, a program to experiment with GA

This IMA Volume in Mathematics and its Applications COMBINATORIAL AND GRAPH-THEORETICAL PROBLEMS IN LINEAR ALGEBRA is based on the proceedings of a workshop that was an integral part of the 1991-92 IMA program on "Applied Linear Algebra." We are grateful to Richard Brualdi, George Cybenko, Alan George, Gene Golub, Mitchell Luskin, and Paul Van Dooren for planning and implementing the year-long program. We especially thank Richard Brualdi, Shmuel Friedland, and Victor Klee for organizing this workshop and editing the proceedings. The financial support of the National Science Foundation made the workshop possible. A vner Friedman Willard Miller, Jr. PREFACE The 1991-1992 program of the Institute for Mathematics and its Applications (IMA) was Applied Linear Algebra. As part of this program, a workshop on Com binatorial and Graph-theoretical Problems in Linear Algebra was held on November 11-15, 1991. The purpose of the workshop was to bring together in an informal setting the diverse group of people who work on problems in linear algebra and matrix theory in which combinatorial or graph~theoretic analysis is a major com ponent. Many of the participants of the workshop enjoyed the hospitality of the IMA for the entire fall quarter, in which the emphasis was discrete matrix analysis.

With its origins in the theories of continuous distributions of dislocations and ofmetalplasticity,inhomogeneitytheoryisarichandvibrant?eldofresearch. The recognition of the important role played by con?gurational or material forces in phenomena such as growth and remodelling is perhaps its greatest present-day impetus. While some excellent comprehensive works approa- ing the subject from di?erent angles have been published, the objective of this monograph is to present a point of view that emphasizes the di?erenti- geometric aspects of inhomogeneity theory. In so doing, we follow the general lines of thought that we have propounded in many publications and presen- tions over the last two decades. Although based on these sources, this book is a stand-alone entity and contains some new results and perspectives. At the same time, it does not intend to present either a historical account of the - velopment of the subject or a comprehensive picture of the various schools of thought that can be encountered by perusing scholarly journals and attending specialized symposia. The book is divided into three parts, the ?rst of which is entirely devoted to the formulation of the theory in the absence of evolution. In other words, time is conspicuously absent from Part I. It opens with the geometric ch- acterization of material inhomogeneity within the context of simple bodies in Chapter 1, followed by extensions to second-grade and Cosserat media in Chapters 2 and 3. The emphasis in this text is on classical electromagnetic theory and electrodynamics, that is, dynamical solutions to the Lorentz-force and Maxwell's equations. The natural appearance of the Minkowski spacetime metric in the paravector space of Clifford's geometric algebra is used to formulate a covariant treatment in special relativity that seamlessly connects spacetime concepts to

the spatial vector treatments common in undergraduate texts. Baylis' geometrical interpretation, using such powerful tools as spinors and projectors, essentially allows a component-free notation and avoids the clutter of indices required in tensorial treatments. The exposition is clear and progresses systematically - from a discussion of electromagnetic units and an explanation of how the SI system can be readily converted to the Gaussian or natural Heaviside-Lorentz systems, to an introduction of geometric algebra and the paravector model of spacetime, and finally, special relativity. Other topics include Maxwell's equation(s), the Lorentz-force law, the Fresnel equations, electromagnetic waves and polarization, wave guides, radiation from accelerating charges and time-dependent currents, the Liénard-Wiechert potentials, and radiation reaction, all of which benefit from the modern relativistic approach. Numerous worked examples and exercises dispersed throughout the text help the reader understand new concepts and facilitate self-study of the material. Each chapter concludes with a set of problems, many with answers. Complete solutions are also available. An excellent feature is the integration of Maple into the text, thereby facilitating difficult calculations. To download accompanying Maple worksheets, please visit http://www.cs.uwindsor.ca/users/b/baylis

This textbook on linear algebra includes the key topics of the subject that most advanced undergraduates need to learn before entering graduate school. All the usual topics, such as complex vector spaces, complex inner products, the Spectral theorem for normal operators, dual spaces, the minimal polynomial, the Jordan canonical form, and the rational canonical form, are covered, along with a chapter on determinants at the end of the book. In addition, there is material throughout the text on linear differential equations and how it integrates with all of the important concepts in linear algebra. This book has several distinguishing features that set it apart from other linear algebra texts. For example: Gaussian elimination is used as the key tool in getting at eigenvalues; it takes an essentially determinant-free approach to linear algebra; and systems of linear differential equations are used as frequent motivation for the reader. Another motivating aspect of the book is the excellent and engaging exercises that abound in this text. This textbook is written for an upper-division undergraduate course on Linear Algebra. The prerequisites for this book are a familiarity with basic matrix algebra and elementary calculus, although any student who is willing to think abstractly should not have too much difficulty in understanding this text.

With a fresh geometric approach that incorporates more than 250 illustrations, this textbook sets itself apart from all others in advanced calculus. Besides the classical capstones--the change of variables formula, implicit and inverse function theorems, the integral theorems of Gauss and Stokes--the text treats other important topics in differential analysis, such as Morse's lemma and the Poincaré lemma. The ideas behind most topics can be understood with just two or three variables. The book incorporates modern computational tools to give visualization real power. Using 2D and 3D graphics, the book offers new insights into fundamental elements of the calculus of differentiable maps. The geometric theme continues with an analysis of the physical meaning of the divergence and the curl at a level of detail not found in other advanced calculus books. This is a textbook for undergraduates and graduate students in mathematics, the physical sciences, and economics. Prerequisites are an introduction to linear algebra and multivariable calculus. There is enough material for a year-long course on advanced calculus and for a variety of semester courses--including topics in geometry. The measured pace of the book, with its extensive examples and illustrations, make it especially suitable for independent study.

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Linear algebra is growing in importance. 3D entertainment, animations in movies and video games are developed using linear algebra. Animated characters are generated using equations straight out of this book. Linear algebra is used to extract knowledge from the massive amounts of data generated from modern technology. The Fourth Edition of this popular text introduces linear algebra in a comprehensive, geometric, and algorithmic way. The authors start with the fundamentals in 2D and 3D, then move on to higher dimensions, expanding on the fundamentals and introducing new topics, which are necessary for many real-life applications and the development of abstract thought. Applications are introduced to motivate topics. The subtitle, A Geometry Toolbox, hints at the book's geometric approach, which is supported by many sketches and figures. Furthermore, the book covers applications of triangles, polygons, conics, and curves. Examples demonstrate each topic in action. This practical approach to a linear algebra course, whether through classroom instruction or self-study, is unique to this book. New to the Fourth Edition: Ten new application sections. A new section on change of basis. This concept now appears in several places. Chapters 14-16 on higher dimensions are notably revised. A deeper look at polynomials in the gallery of spaces. Introduces the QR decomposition and its relevance to least squares. Similarity and diagonalization are given more attention, as are eigenfunctions. A longer thread on least squares, running from orthogonal projections to a solution via SVD and the pseudoinverse. More applications for PCA have been added. More examples, exercises, and more on the kernel and general linear spaces. A list of applications has been added in Appendix A. The book gives instructors the option of tailoring the course for the primary interests of their students: mathematics, engineering, science, computer graphics, and geometric modeling.

This is an undergraduate textbook suitable for linear algebra courses. This is the only textbook that develops the linear algebra hand-in-hand with the geometry of linear (or affine) spaces in such a way that the understanding of each reinforces the other. The text is divided into two parts: Part I is on linear algebra and affine geometry, finishing with a chapter on transformation groups; Part II is on quadratic forms and their geometry (Euclidean geometry), including a chapter on finite subgroups of 0 (2). Each of the 23 chapters concludes with a generous helping of exercises, and a selection of these have solutions at the end of the book. The chapters also contain many examples, both numerical worked examples (mostly in 2 and 3 dimensions), as well as examples which take some of the ideas further. Many of the chapters contain "complements" which develop more special topics, and which can be omitted on a first reading. The structure of the book is designed to allow as much flexibility as possible in designing a course, either by omitting whole chapters or by omitting the "complements" or specific examples. In this book we lead the student to an understanding of elementary linear algebra by emphasizing the geometric significance of the subject. Our experience in teaching beginning undergraduates over the years has convinced us that students learn the new ideas of linear algebra best when these ideas are grounded in the familiar geometry of two and three dimensions. Many important notions of linear algebra already occur in these dimensions in a non-trivial way, and a student with a confident grasp of these ideas will encounter little difficulty in extending them to higher dimensions and to more abstract algebraic systems. Moreover, we feel that this geometric approach provides a solid basis for the linear algebra needed in engineering, physics, biology, and chemistry, as well as in economics and statistics. The great advantage of

beginning with a thorough study of the linear algebra of the plane is that students are introduced quickly to the most important new concepts while they are still on the familiar ground of two-dimensional geometry. In short order, the student sees and uses the notions of dot product, linear transformations, determinants, eigenvalues, and quadratic forms. This is done in Chapters 2.0-2.7. Then the very same outline is used in Chapters 3.0-3.7 to present the linear algebra of three-dimensional space, so that the former ideas are reinforced while new concepts are being introduced.

Multivariable Mathematics combines linear algebra and multivariable mathematics in a rigorous approach. The material is integrated to emphasize the recurring theme of implicit versus explicit that persists in linear algebra and analysis. In the text, the author includes all of the standard computational material found in the usual linear algebra and multivariable calculus courses, and more, interweaving the material as effectively as possible, and also includes complete proofs. * Contains plenty of examples, clear proofs, and significant motivation for the crucial concepts. * Numerous exercises of varying levels of difficulty, both computational and more proof-oriented. * Exercises are arranged in order of increasing difficulty.

Introduction to Linear Algebra in Geology introduces linear algebra to students of geology and explores the possibilities of using the techniques as an aid to solving geological problems which can be solved numerically. A basic knowledge of geology is assumed.

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Linear AlgebraA Geometric ApproachMacmillan

Useful Concepts and Results at the Heart of Linear Algebra A one- or two-semester course for a wide variety of students at the sophomore/junior undergraduate level A Modern Introduction to Linear Algebra provides a rigorous yet accessible matrix-oriented introduction to the essential concepts of linear algebra. Concrete, easy-to-understand examples motivate the theory. The book first discusses vectors, Gaussian elimination, and reduced row echelon forms. It then offers a thorough introduction to matrix algebra, including defining the determinant naturally from the PA=LU factorization of a matrix. The author goes on to cover finite-dimensional real vector spaces, infinite-dimensional spaces, linear transformations, and complex vector spaces. The final chapter presents Hermitian and normal matrices as well as quadratic forms. Taking a computational, algebraic, and geometric approach to the subject, this book provides the foundation for later courses in higher mathematics. It also shows how linear algebra can be used in various areas of application. Although written in a "pencil and paper" manner, the text offers ample opportunities to enhance learning with calculators or computer usage. Solutions manual available for qualifying instructors

Vehicles are complex systems (non-linear, multi-variable) where the abundance of embedded controllers should ensure better security. This book aims at emphasizing the interest and potential of Linear Parameter Varying methods within the framework of vehicle dynamics, e.g. proposed control-oriented model, complex enough to handle some system non linearities but still simple for control or observer design, take into account the adaptablity of the vehicle's response to driving situations, to the driver request and/or to the road sollicitations, manage interactions between various actuators to optimize the dynamic behavior of vehicles. This book results from the 32th International Summer School in Automatic that held in Grenoble, France, in September 2011, where recent methods (based on robust control and LPV technics), then applied to the control of vehicle dynamics, have been presented. After some theoretical background and a view on some recent works on LPV approaches (for modelling, analysis, control, observation and diagnosis), the main emphasis is put on road vehicles but some illustrations are concerned with railway, aerospace and underwater vehicles. The main objective of the book is to demonstrate the value of this approach for controlling the dynamic behavior of vehicles. It presents, in a rm way, background and new results on LPV methods and their application to vehicle dynamics.

This outstanding text starts off using vectors and the geometric approach, featuring a computational emphasis. The authors provide students with easy-to-read explanations, examples, proofs, and procedures. Elementary Linear Algebra can be used in both a matrix-oriented course, or a more traditionally structured course.

In writing this monograph my objective is to present arecent, 'geometrie' approach to the structural synthesis of multivariable control systems that are linear, time-invariant, and of finite dynamic order. The book is addressed to graduate students specializing in control, to engineering scientists engaged in control systems research and development, and to mathematicians with some previous acquaintance with control problems. The label 'geometrie' is applied for several reasons. First and obviously, the setting is linear state space and the mathematics chiefly linear algebra in abstract (geometrie) style. The basic ideas are the familiar system concepts of controllability and observability, thought of as geometrie properties of distinguished state subspaces. Indeed, the geometry was first brought in out of revulsion against the orgy of matrix manipulation which linear control theory mainly consisted of, not so long ago. But secondlyand of greater interest, the geometrie setting rather quickly suggested new methods of attacking synthesis which have proved to be intuitive and economical; they are also easily reduced to matrix arith metic as soonas you want to compute. The essence of the 'geometrie' approach is just this: instead of looking directly for a feedback laW (say u = Fx) which would solve your synthesis problem if a solution exists, first characterize solvability as a verifiable property of some constructible state subspace, say J. Then, if all is weIl, you may calculate F from J quite easily.

Linear Algebra: A Geometric Approach, Second Edition, is a text that not only presents the standard computational aspects of linear algebra and interesting applications, it guides students to think about mathematical concepts and write rigorous mathematical arguments. This thought-provoking introduction to the subject and its myriad applications is interesting to the science or engineering student but will also help the mathematics student make the transition to more abstract advanced courses. The

second edition has been updated with additional examples and exercises and has been streamlined for easier teaching and studying.

This is a unified treatment of the various algebraic approaches to geometric spaces. The study of algebraic curves in the complex projective plane is the natural link between linear geometry at an undergraduate level and algebraic geometry at a graduate level, and it is also an important topic in geometric applications, such as cryptography. 380 years ago, the work of Fermat and Descartes led us to study geometric problems using coordinates and equations. Today, this is the most popular way of handling geometrical problems. Linear algebra provides an efficient tool for studying all the first degree (lines, planes) and second degree (ellipses, hyperboloids) geometric figures, in the affine, the Euclidean, the Hermitian and the projective contexts. But recent applications of mathematics, like cryptography, need these notions not only in real or complex cases, but also in more general settings, like in spaces constructed on finite fields. And of course, why not also turn our attention to geometric figures of higher degrees? Besides all the linear aspects of geometry in their most general setting, this book also describes useful algebraic tools for studying curves of arbitrary degree and investigates results as advanced as the Bezout theorem, the Cramer paradox, topological group of a cubic, rational curves etc. Hence the book is of interest for all those who have to teach or study linear geometry: affine, Euclidean, Hermitian, projective; it is also of great interest to those who do not want to restrict themselves to the undergraduate level of geometric figures of degree one or two.

Clear prose, tight organization, and a wealth of examples and computational techniques make Basic Matrix Algebra with Algorithms and Applications an outstanding introduction to linear algebra. The author designed this treatment specifically for freshman majors in mathematical subjects and upper-level students in natural resources, the social sciences, business, or any discipline that eventually requires an understanding of linear models. With extreme pedagogical clarity that avoids abstraction wherever possible, the author emphasizes minimal polynomials and their computation using a Krylov algorithm. The presentation is highly visual and relies heavily on work with a graphing calculator to allow readers to focus on concepts and techniques rather than on tedious arithmetic. Supporting materials, including test preparation Maple worksheets, are available for download from the Internet. This unassuming but insightful and remarkably original treatment is organized into bite-sized, clearly stated objectives. It goes well beyond the LACSG recommendations for a first course while still implementing their philosophy and core material. Classroom tested with great success, it prepares readers well for the more advanced studies their fields ultimately will require.

A novel exposition of the analysis of variance and regression. The key feature here is that these tools are viewed in their natural mathematical setting - the geometry of finite dimensions. This is because geometry clarifies the basic statistics and unifies the many aspects of analysing variance and regression.

Differential geometry is the study of the curvature and calculus of curves and surfaces. A New Approach to Differential Geometry using Clifford's Geometric Algebra simplifies the discussion to an accessible level of differential geometry by introducing Clifford algebra. This presentation is relevant because Clifford algebra is an effective tool for dealing with the rotations intrinsic to the study of curved space. Complete with chapter-by-chapter exercises, an overview of general relativity, and brief biographies of historical figures, this comprehensive textbook presents a valuable introduction to differential geometry. It will serve as a useful resource for upper-level undergraduates, beginning-level graduate students, and researchers in the algebra and physics communities.

This accessible book for beginners uses intuitive geometric concepts to create abstract algebraic theory with a special emphasis on geometric characterizations. The book applies known results to describe various geometries and their invariants, and presents problems concerned with linear algebra, such as in real and complex analysis, differential equations, differentiable manifolds, differential geometry, Markov chains and transformation groups. The clear and inductive approach makes this book unique among existing books on linear algebra both in presentation and in content.

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