

WHAT IS A LINEAR TRANSFORMATION IN LINEAR ALGEBRA

WHAT IS A LINEAR TRANSFORMATION IN LINEAR ALGEBRA IS A FUNDAMENTAL CONCEPT THAT PLAYS A PIVOTAL ROLE IN VARIOUS FIELDS SUCH AS MATHEMATICS, ENGINEERING, PHYSICS, AND COMPUTER SCIENCE. AT ITS CORE, A LINEAR TRANSFORMATION IS A SPECIFIC TYPE OF FUNCTION THAT MAPS VECTORS FROM ONE VECTOR SPACE TO ANOTHER WHILE PRESERVING THE OPERATIONS OF VECTOR ADDITION AND SCALAR MULTIPLICATION. UNDERSTANDING LINEAR TRANSFORMATIONS IS ESSENTIAL FOR GRASPING MORE COMPLEX TOPICS IN LINEAR ALGEBRA, INCLUDING MATRIX OPERATIONS, EIGENVALUES, AND EIGENVECTORS. THIS ARTICLE WILL DELVE INTO THE DEFINITION AND PROPERTIES OF LINEAR TRANSFORMATIONS, PROVIDE EXAMPLES, AND EXPLORE THEIR APPLICATIONS IN REAL-WORLD SCENARIOS. THE CONTENT WILL ALSO COVER THE RELATIONSHIP BETWEEN LINEAR TRANSFORMATIONS AND MATRICES, SHOWCASING HOW THEY CAN BE REPRESENTED AND MANIPULATED.

- DEFINITION OF LINEAR TRANSFORMATION
- PROPERTIES OF LINEAR TRANSFORMATIONS
- EXAMPLES OF LINEAR TRANSFORMATIONS
- MATRIX REPRESENTATION OF LINEAR TRANSFORMATIONS
- APPLICATIONS OF LINEAR TRANSFORMATIONS
- CONCLUSION

DEFINITION OF LINEAR TRANSFORMATION

A LINEAR TRANSFORMATION IS A FUNCTION $T: V \rightarrow W$ BETWEEN TWO VECTOR SPACES V AND W THAT SATISFIES TWO MAIN PROPERTIES: ADDITIVITY AND HOMOGENEITY. IN SIMPLER TERMS, A FUNCTION T IS A LINEAR TRANSFORMATION IF THE FOLLOWING CONDITIONS ARE MET FOR ANY VECTORS u AND v IN V AND ANY SCALAR c :

1. **ADDITIVITY:** $T(u + v) = T(u) + T(v)$
2. **HOMOGENEITY:** $T(cu) = cT(u)$

THIS MEANS THAT WHEN TWO VECTORS ARE ADDED TOGETHER AND THEN TRANSFORMED, THE RESULT IS THE SAME AS TRANSFORMING EACH VECTOR SEPARATELY AND THEN ADDING THOSE RESULTS. SIMILARLY, WHEN A VECTOR IS MULTIPLIED BY A SCALAR AND THEN TRANSFORMED, THE RESULT EQUALS THE SCALAR MULTIPLIED BY THE TRANSFORMED VECTOR. THESE PROPERTIES ENSURE THAT THE STRUCTURE OF THE VECTOR SPACE IS PRESERVED UNDER THE TRANSFORMATION.

PROPERTIES OF LINEAR TRANSFORMATIONS

LINEAR TRANSFORMATIONS HAVE SEVERAL IMPORTANT PROPERTIES THAT ARE CRITICAL FOR THEIR STUDY AND APPLICATION. UNDERSTANDING THESE PROPERTIES HELPS IN ANALYZING THE BEHAVIOR OF LINEAR MAPPINGS AND THEIR EFFECTS ON VECTOR SPACES.

1. ZERO VECTOR PROPERTY

ONE FUNDAMENTAL PROPERTY OF LINEAR TRANSFORMATIONS IS THAT THEY MAP THE ZERO VECTOR OF THE DOMAIN TO THE ZERO VECTOR OF THE CODOMAIN:

IF T IS A LINEAR TRANSFORMATION, THEN $T(0) = 0$, WHERE 0 REPRESENTS THE ZERO VECTOR IN BOTH SPACES. THIS PROPERTY

IS ESSENTIAL AS IT ESTABLISHES THAT THE TRANSFORMATION DOES NOT DISTORT THE ORIGIN OF THE VECTOR SPACE.

2. COMPOSITION OF LINEAR TRANSFORMATIONS

THE COMPOSITION OF TWO LINEAR TRANSFORMATIONS IS ALSO A LINEAR TRANSFORMATION. IF $T: V \rightarrow W$ AND $S: W \rightarrow U$ ARE LINEAR TRANSFORMATIONS, THEN THE COMPOSITION $S(T(v))$ IS A LINEAR TRANSFORMATION FROM V TO U . THIS PROPERTY IS CRUCIAL WHEN DEALING WITH MULTIPLE TRANSFORMATIONS IN SEQUENCE.

3. INVERTIBILITY

A LINEAR TRANSFORMATION T IS INVERTIBLE IF THERE EXISTS ANOTHER LINEAR TRANSFORMATION S SUCH THAT $S(T(v)) = v$ FOR ALL v IN V . THE EXISTENCE OF AN INVERSE TRANSFORMATION IS SIGNIFICANT IN SOLVING LINEAR EQUATIONS AND UNDERSTANDING THE STRUCTURE OF VECTOR SPACES.

EXAMPLES OF LINEAR TRANSFORMATIONS

TO SOLIDIFY THE UNDERSTANDING OF LINEAR TRANSFORMATIONS, CONSIDER THE FOLLOWING EXAMPLES:

1. SCALING TRANSFORMATION

A COMMON EXAMPLE OF A LINEAR TRANSFORMATION IS SCALING. FOR A VECTOR v IN $\mathbb{R}^2$, A SCALING TRANSFORMATION CAN BE DEFINED AS $T(v) = k v$, WHERE k IS A SCALAR. THIS TRANSFORMATION STRETCHES OR SHRINKS THE VECTOR WHILE MAINTAINING ITS DIRECTION.

2. ROTATION TRANSFORMATION

ANOTHER EXAMPLE IS A ROTATION TRANSFORMATION. FOR A VECTOR v IN $\mathbb{R}^2$, A ROTATION BY AN ANGLE θ CAN BE DEFINED USING A ROTATION MATRIX:

$T(v) = R(\theta)v$, WHERE $R(\theta) = \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix}$ IS THE ROTATION MATRIX. THIS TRANSFORMATION ROTATES THE VECTOR AROUND THE ORIGIN BY THE SPECIFIED ANGLE, PRESERVING ITS LENGTH.

3. REFLECTION TRANSFORMATION

REFLECTION ACROSS A LINE IS ALSO A LINEAR TRANSFORMATION. FOR INSTANCE, REFLECTING ACROSS THE X-AXIS CAN BE EXPRESSED AS $T(x, y) = (x, -y)$. THIS TRANSFORMATION MAINTAINS THE DISTANCE FROM THE X-AXIS WHILE FLIPPING THE DIRECTION OF THE Y-COORDINATE.

MATRIX REPRESENTATION OF LINEAR TRANSFORMATIONS

LINEAR TRANSFORMATIONS CAN BE CONVENIENTLY REPRESENTED USING MATRICES. IF T IS A LINEAR TRANSFORMATION FROM $\mathbb{R}^n$ TO $\mathbb{R}^m$, THERE EXISTS A MATRIX A SUCH THAT $T(v) = Av$ FOR ALL VECTORS v IN $\mathbb{R}^n$. THIS RELATIONSHIP IS INCREDIBLY USEFUL, AS IT ALLOWS THE USE OF MATRIX ALGEBRA TO ANALYZE AND COMPUTE THE EFFECTS OF LINEAR TRANSFORMATIONS.

1. FINDING THE MATRIX REPRESENTATION

TO FIND THE MATRIX REPRESENTATION OF A LINEAR TRANSFORMATION, ONE TYPICALLY EVALUATES THE TRANSFORMATION ON THE STANDARD BASIS VECTORS OF THE DOMAIN. IF $e_1, e_2, \dots, e_n$ ARE THE STANDARD BASIS VECTORS OF $\mathbb{R}^n$, THEN THE COLUMNS OF THE MATRIX A ARE GIVEN BY:

- $A_1 = T(e_1)$
- $A_2 = T(e_2)$

- ...
- $A[\vec{v}] = T(\vec{v})$

THIS METHOD EFFECTIVELY CAPTURES HOW THE TRANSFORMATION ACTS ON ALL POSSIBLE VECTORS IN THE VECTOR SPACE.

APPLICATIONS OF LINEAR TRANSFORMATIONS

LINEAR TRANSFORMATIONS HAVE A MULTITUDE OF APPLICATIONS ACROSS VARIOUS FIELDS, SHOWCASING THEIR VERSATILITY AND IMPORTANCE.

1. COMPUTER GRAPHICS

IN COMPUTER GRAPHICS, LINEAR TRANSFORMATIONS ARE ESSENTIAL FOR MANIPULATING IMAGES AND SHAPES. SCALING, TRANSLATION, ROTATION, AND REFLECTION ARE ALL PERFORMED USING LINEAR TRANSFORMATIONS. THIS ALLOWS FOR EFFICIENT RENDERING AND MODIFICATION OF GRAPHICAL OBJECTS IN VARIOUS APPLICATIONS.

2. DATA SCIENCE AND MACHINE LEARNING

LINEAR TRANSFORMATIONS ARE USED IN DATA PREPROCESSING TECHNIQUES SUCH AS PRINCIPAL COMPONENT ANALYSIS (PCA). PCA INVOLVES TRANSFORMING DATA INTO A NEW COORDINATE SYSTEM WHERE THE GREATEST VARIANCE LIES ALONG THE FIRST COORDINATE, SIMPLIFYING THE DATA ANALYSIS PROCESS.

3. ENGINEERING

IN ENGINEERING, LINEAR TRANSFORMATIONS ARE USED IN STRUCTURAL ANALYSIS, CONTROL THEORY, AND SYSTEMS MODELING. THEY HELP IN SIMPLIFYING COMPLEX SYSTEMS INTO MANAGEABLE LINEAR MODELS FOR ANALYSIS AND DESIGN.

CONCLUSION

UNDERSTANDING WHAT A LINEAR TRANSFORMATION IN LINEAR ALGEBRA ENTAILS IS CRUCIAL FOR DELVING INTO MORE ADVANCED MATHEMATICAL CONCEPTS AND APPLICATIONS. LINEAR TRANSFORMATIONS NOT ONLY PRESERVE THE STRUCTURE OF VECTOR SPACES BUT ALSO PROVIDE THE NECESSARY TOOLS FOR PRACTICAL APPLICATIONS IN VARIOUS DOMAINS SUCH AS COMPUTER GRAPHICS, ENGINEERING, AND DATA SCIENCE. BY RECOGNIZING THEIR PROPERTIES, REPRESENTATIONS, AND EXAMPLES, ONE CAN APPRECIATE THE SIGNIFICANT ROLE THAT LINEAR TRANSFORMATIONS PLAY IN BOTH THEORETICAL AND APPLIED MATHEMATICS.

Q: WHAT IS THE DIFFERENCE BETWEEN A LINEAR TRANSFORMATION AND A NON-LINEAR TRANSFORMATION?

A: A LINEAR TRANSFORMATION SATISFIES THE PROPERTIES OF ADDITIVITY AND HOMOGENEITY, MEANING IT PRESERVES VECTOR ADDITION AND SCALAR MULTIPLICATION. A NON-LINEAR TRANSFORMATION DOES NOT ADHERE TO THESE PROPERTIES AND CAN DISTORT THE STRUCTURE OF THE VECTOR SPACE.

Q: HOW CAN I DETERMINE IF A GIVEN FUNCTION IS A LINEAR TRANSFORMATION?

A: TO DETERMINE IF A FUNCTION T IS A LINEAR TRANSFORMATION, CHECK IF IT SATISFIES THE TWO PROPERTIES: $T(u + v) = T(u) + T(v)$ FOR ALL VECTORS u AND v , AND $T(cu) = cT(u)$ FOR ANY SCALAR c .

Q: CAN ALL LINEAR TRANSFORMATIONS BE REPRESENTED BY MATRICES?

A: YES, ALL LINEAR TRANSFORMATIONS FROM $\mathbb{R}^n$ TO $\mathbb{R}^m$ CAN BE REPRESENTED BY MATRICES. THE MATRIX REPRESENTATION ENCAPSULATES THE ACTION OF THE TRANSFORMATION ON VECTORS IN THE DOMAIN.

Q: WHAT ROLE DO LINEAR TRANSFORMATIONS PLAY IN COMPUTER GRAPHICS?

A: IN COMPUTER GRAPHICS, LINEAR TRANSFORMATIONS ARE USED FOR MANIPULATING GRAPHICAL OBJECTS THROUGH OPERATIONS SUCH AS SCALING, ROTATING, AND TRANSLATING IMAGES EFFICIENTLY USING MATRIX REPRESENTATIONS.

Q: WHAT IS THE SIGNIFICANCE OF THE ZERO VECTOR IN LINEAR TRANSFORMATIONS?

A: THE ZERO VECTOR IS SIGNIFICANT BECAUSE LINEAR TRANSFORMATIONS MUST MAP THE ZERO VECTOR OF THE DOMAIN TO THE ZERO VECTOR OF THE CODOMAIN, ENSURING THE PRESERVATION OF THE ORIGIN IN THE VECTOR SPACE.

Q: ARE LINEAR TRANSFORMATIONS LIMITED TO TWO-DIMENSIONAL SPACES?

A: NO, LINEAR TRANSFORMATIONS CAN BE APPLIED TO VECTOR SPACES OF ANY DIMENSION, INCLUDING HIGHER-DIMENSIONAL SPACES SUCH AS $\mathbb{R}^n$, WHERE n CAN BE ANY POSITIVE INTEGER.

Q: HOW DO LINEAR TRANSFORMATIONS RELATE TO EIGENVALUES AND EIGENVECTORS?

A: IN LINEAR ALGEBRA, EIGENVALUES AND EIGENVECTORS ARE ASSOCIATED WITH LINEAR TRANSFORMATIONS. AN EIGENVECTOR OF A TRANSFORMATION T IS A NON-ZERO VECTOR THAT ONLY GETS SCALED BY T , WITH THE SCALING FACTOR BEING THE CORRESPONDING EIGENVALUE.

Q: WHAT IS THE ROLE OF BASIS VECTORS IN LINEAR TRANSFORMATIONS?

A: BASIS VECTORS ARE USED TO REPRESENT LINEAR TRANSFORMATIONS IN MATRIX FORM. THE TRANSFORMATION'S EFFECT ON THE STANDARD BASIS VECTORS DETERMINES THE COLUMNS OF THE TRANSFORMATION MATRIX.

Q: HOW CAN I VISUALIZE LINEAR TRANSFORMATIONS?

A: LINEAR TRANSFORMATIONS CAN BE VISUALIZED USING GEOMETRIC REPRESENTATIONS OF VECTORS AND THEIR TRANSFORMATIONS ON A GRAPH. FOR INSTANCE, ONE CAN VISUALIZE SCALING BY OBSERVING HOW THE LENGTH OF VECTORS CHANGES WITHOUT ALTERING THEIR DIRECTION.

Q: CAN LINEAR TRANSFORMATIONS BE INVERTED? IF SO, HOW?

A: YES, A LINEAR TRANSFORMATION IS INVERTIBLE IF THERE EXISTS ANOTHER LINEAR TRANSFORMATION THAT REVERSES ITS EFFECT. THIS IS DETERMINED BY THE PROPERTIES OF THE TRANSFORMATION MATRIX; SPECIFICALLY, IT MUST BE A NON-SINGULAR MATRIX (HAVING A NON-ZERO DETERMINANT).

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Charles G. Cullen, 1990-01-01 Undergraduate-level introduction to linear algebra and matrix theory. Explores matrices and linear systems, vector spaces, determinants, spectral decomposition, Jordan canonical form, much more. Over 375 problems. Selected answers. 1972 edition.

what is a linear transformation in linear algebra: Linear Algebra Meighan I. Dillon,

2022-10-14 This textbook is directed towards students who are familiar with matrices and their use in solving systems of linear equations. The emphasis is on the algebra supporting the ideas that make linear algebra so important, both in theoretical and practical applications. The narrative is written to bring along students who may be new to the level of abstraction essential to a working understanding of linear algebra. The determinant is used throughout, placed in some historical perspective, and defined several different ways, including in the context of exterior algebras. The text details proof of the existence of a basis for an arbitrary vector space and addresses vector spaces over arbitrary fields. It develops LU-factorization, Jordan canonical form, and real and complex inner product spaces. It includes examples of inner product spaces of continuous complex functions on a real interval, as well as the background material that students may need in order to follow those discussions. Special classes of matrices make an entrance early in the text and subsequently appear throughout. The last chapter of the book introduces the classical groups.

what is a linear transformation in linear algebra: Linear Transformation Nita H. Shah,

Urmila B. Chaudhari, 2020-12-29 This book introduces linear transformation and its key results, which have applications in engineering, physics, and various branches of mathematics. Linear transformation is a difficult subject for students. This concise text provides an in-depth overview of linear transformation. It provides multiple-choice questions, covers enough examples for the reader to gain a clear understanding, and includes exact methods with specific shortcuts to reach solutions for particular problems. Research scholars and students working in the fields of engineering, physics, and different branches of mathematics need to learn the concepts of linear transformation to solve their problems. This book will serve their need instead of having to use the more complex texts that contain more concepts than needed. The chapters mainly discuss the definition of linear transformation, properties of linear transformation, linear operators, composition of two or more linear transformations, kernels and range of linear transformation, inverse transformation, one-to-one and onto transformation, isomorphism, matrix linear transformation, and similarity of two matrices.

what is a linear transformation in linear algebra: Introduction to Matrices and Linear Transformations Daniel Talbot Finkbeiner, 1960

what is a linear transformation in linear algebra: Linear Algebra: Core Topics For The First Course Dragu Atanasiu, Piotr Mikusinski, 2020-03-26

The book is an introduction to linear algebra intended as a textbook for the first course in linear algebra. In the first six chapters we present the core topics: matrices, the vector space $\mathbb{R}^n$, orthogonality in $\mathbb{R}^n$, determinants, eigenvalues and eigenvectors, and linear transformations. The book gives students an opportunity to better understand linear algebra in the next three chapters: Jordan forms by examples, singular value decomposition, and quadratic forms and positive definite matrices. In the first nine chapters everything is formulated in terms of $\mathbb{R}^n$. This makes the ideas of linear algebra easier to understand. The general vector spaces are introduced in Chapter 10. The last chapter presents problems solved with a computer algebra system. At the end of the book we have results or solutions for odd numbered exercises.

what is a linear transformation in linear algebra: Linear Algebra Larry E. Knop,

2008-08-28 Linear Algebra: A First Course with Applications explores the fundamental ideas of linear algebra, including vector spaces, subspaces, basis, span, linear independence, linear transformation, eigenvalues, and eigenvectors, as well as a variety of applications, from inventories to graphics to Google's PageRank. Unlike other texts on the subject, thi

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2022-09-03 The purpose of this book is to explain linear algebra clearly for beginners. In doing so, the author states and explains somewhat advanced topics such as Hermitian products and Jordan normal forms. Starting from the definition of matrices, it is made clear with examples that matrices and matrix operation are abstractions of tables and operations of tables. The author also maintains that systems of linear equations are the starting point of linear algebra, and linear algebra and linear equations are closely connected. The solutions to systems of linear equations are found by solving matrix equations in the row-reduction of matrices, equivalent to the Gauss elimination method of solving systems of linear equations. The row-reductions play important roles in calculation in this book. To calculate row-reductions of matrices, the matrices are arranged vertically, which is seldom seen but is convenient for calculation. Regular matrices and determinants of matrices are defined and explained. Furthermore, the resultants of polynomials are discussed as an application of determinants. Next, abstract vector spaces over a field K are defined. In the book, however, mainly vector spaces are considered over the real number field and the complex number field, in case readers are not familiar with abstract fields. Linear mappings and linear transformations of vector spaces and representation matrices of linear mappings are defined, and the characteristic polynomials and minimal polynomials are explained. The diagonalizations of linear transformations and square matrices are discussed, and inner products are defined on vector spaces over the real number field. Real symmetric matrices are considered as well, with discussion of quadratic forms. Next, there are definitions of Hermitian inner products. Hermitian transformations, unitary transformations, normal transformations and the spectral resolution of normal transformations and matrices are explained. The book ends with Jordan normal forms. It is shown that any transformations of vector spaces over the complex number field have matrices of Jordan normal forms as representation matrices.

what is a linear transformation in linear algebra: *Algebras of Linear Transformations*

Douglas R. Farenick, 2012-12-06 The aim of this book is twofold: (i) to give an exposition of the basic theory of finite-dimensional algebras at a level that is appropriate for senior undergraduate and first-year graduate students, and (ii) to provide the mathematical foundation needed to prepare the reader for the advanced study of any one of several fields of mathematics. The subject under study is by no means new—indeed it is classical yet a book that offers a straightforward and concrete treatment of this theory seems justified for several reasons. First, algebras and linear transformations in one guise or another are standard features of various parts of modern mathematics. These include well-entrenched fields such as representation theory, as well as newer ones such as quantum groups. Second, a study of the elementary theory of finite-dimensional algebras is particularly useful in motivating and casting light upon more sophisticated topics such as module theory and operator algebras. Indeed, the reader who acquires a good understanding of the basic theory of algebras is well positioned to appreciate results in operator algebras, representation theory, and ring theory. In return for their efforts, readers are rewarded by the results themselves, several of which are fundamental theorems of striking elegance.

what is a linear transformation in linear algebra: **Linear Algebra** Ross Allen Beaumont, 1972

what is a linear transformation in linear algebra: **Linear Algebra: An Introduction**

Richard Bronson, Gabriel B. Costa, 2007-03-05 In this appealing and well-written text, Richard Bronson gives readers a substructure for a firm understanding of the abstract concepts of linear algebra and its applications. The author starts with the concrete and computational, and leads the reader to a choice of major applications (Markov chains, least-squares approximation, and solution of differential equations using Jordan normal form). The first three chapters address the basics: matrices, vector spaces, and linear transformations. The next three cover eigenvalues, Euclidean inner products, and Jordan canonical forms, offering possibilities that can be tailored to the instructor's taste and to the length of the course. Bronson's approach to computation is modern and algorithmic, and his theory is clean and straightforward. Throughout, the views of the theory presented are broad and balanced. Key material is highlighted in the text and summarized at the end

of each chapter. The book also includes ample exercises with answers and hints. With its inclusion of all the needed features, this text will be a pleasure for professionals, teachers, and students. Introduces deductive reasoning and helps the reader develop a facility with mathematical proofs Gives computational algorithms for finding eigenvalues and eigenvectors Provides a balanced approach to computation and theory Superb motivation and writing Excellent exercise sets, ranging from drill to theoretical/challenging Useful and interesting applications not found in other introductory linear algebra texts

what is a linear transformation in linear algebra: Generalized Inverses of Linear Transformations Stephen L. Campbell, Carl D. Meyer, 2009-03-26 Provides comprehensive coverage of the mathematical theory of generalized inverses and a wide range of important and practical applications.

what is a linear transformation in linear algebra: A First Course In Linear Algebra Shou-te Chang, Minking Eie, 2016-07-13 A First Course in Linear Algebra is written by two experts from algebra who have more than 20 years of experience in algebra, linear algebra and number theory. It prepares students with no background in Linear Algebra. Students, after mastering the materials in this textbook, can already understand any Linear Algebra used in more advanced books and research papers in Mathematics or in other scientific disciplines. This book provides a solid foundation for the theory dealing with finite dimensional vector spaces. It explains in details the relation between linear transformations and matrices. One may thus use different viewpoints to manipulate a matrix instead of a one-sided approach. Although most of the examples are for real and complex matrices, a vector space over a general field is briefly discussed. Several optional sections are devoted to applications to demonstrate the power of Linear Algebra.

what is a linear transformation in linear algebra: *Essential Linear Algebra* Jared M. Maruskin, 2012-12 This text introduces linear algebra--boiled to its essence--presented in a clear and concise fashion. Designed around a single-semester undergraduate course, Essential Linear Algebra introduces key concepts, various real-world applications, and provides detailed yet understandable proofs of key results that are aimed towards students with no advanced preparation in proof writing. The level of sophistication gradually increases from beginning to end in order to prepare students for subsequent studies. We begin with a detailed introduction to systems of linear equations and elementary row operations. We then advance to a discussion of linear transformations, which provide a second, more geometric, interpretation of the operation of matrix-vector product. We go on to introduce vector spaces and their subspaces, the image and kernel of a transformation, and change of coordinates. Following, we discuss matrices of orthogonal projections and orthogonal matrices. Our penultimate chapter is devoted to the theory of determinants, which are presented, first, in terms of area and volume expansion factors of 2×2 and 3×3 matrices, respectively. We use a geometric understanding of volume in n -dimensions to introduce general determinants axiomatically as multilinear, antisymmetric mappings, and prove existence and uniqueness. Our final chapter is devoted to the theory of eigenvalues and eigenvectors. We conclude with a number of discussions on various types of diagonalization: real, complex, and orthogonal.

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emphasis on the geometric interpretation and viewpoint as well as a very complete treatment of the singular value decomposition. The book includes over 800 exercises and numerous references to the author's custom software Linear Algebra Toolkit.

what is a linear transformation in linear algebra: Introduction to Matrices and Linear Transformations Daniel T. Finkbeiner, 2013-10-21 This versatile undergraduate-level text contains enough material for a one-year course and serves as a support text and reference. It combines formal theory and related computational techniques. Solutions to selected exercises. 1978 edition.

what is a linear transformation in linear algebra: Linear Algebra Róbert Freud, 2024-10-25 This textbook invites readers to dive into the mathematical ideas of linear algebra. Offering a gradual yet rigorous introduction, the author illuminates the structure, order, symmetry, and beauty of the topic. Opportunities to explore, master, and extend the theory abound, with generous exercise sets embodying the Hungarian tradition of active problem-solving. Determinants, matrices, and systems of linear equations begin the book. This unique ordering offers insights from determinants early on, while also admitting re-ordering if desired. Chapters on vector spaces, linear maps, and eigenvalues and eigenvectors follow. Bilinear functions and Euclidean spaces build on the foundations laid in the first half of the book to round out the core material. Applications in combinatorics include Hilbert's third problem, Oddtown and Eventown problems, and Sidon sets, a favorite of Paul Erdős. Coding theory applications include error-correction, linear, Hamming, and BCH codes. An appendix covers the algebraic basics used in the text. Ideal for students majoring in mathematics and computer science, this textbook promotes a deep and versatile understanding of linear algebra. Familiarity with mathematical proof is assumed, though no prior knowledge of linear algebra is needed. Supplementary electronic materials support teaching and learning, with selected answers, hints, and solutions, and an additional problem bank for instructors.

what is a linear transformation in linear algebra: Linear Algebra and Matrices Shmuel Friedland, Mohsen Aliabadi, 2018-01-30 This introductory textbook grew out of several courses in linear algebra given over more than a decade and includes such helpful material as constructive discussions about the motivation of fundamental concepts, many worked-out problems in each chapter, and topics rarely covered in typical linear algebra textbooks. The authors use abstract notions and arguments to give the complete proof of the Jordan canonical form and, more generally, the rational canonical form of square matrices over fields. They also provide the notion of tensor products of vector spaces and linear transformations. Matrices are treated in depth, with coverage of the stability of matrix iterations, the eigenvalue properties of linear transformations in inner product spaces, singular value decomposition, and min-max characterizations of Hermitian matrices and nonnegative irreducible matrices. The authors show the many topics and tools encompassed by modern linear algebra to emphasize its relationship to other areas of mathematics. The text is intended for advanced undergraduate students. Beginning graduate students seeking an introduction to the subject will also find it of interest.

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what is a linear transformation in linear algebra: Linear Algebra with Applications Otto Bretscher, 2001 For courses in Introductory Linear Algebra and Matrix Methods. With the most geometric presentation now available, this text emphasizes linear transformations as a unifying theme, and enables students to 'do' both computational and abstract maths in each chapter. A second theme is introduced half way through the text - when eigenvectors are reached - on dynamical systems. It also includes a wider range of problem sets than found in any other text in this market. NEW - Earlier introduction to vector spaces ('linear spaces'). Extensive visualization and geometrical interpretations throughout - E.g., the determinant; the Gram-Schmidt process; the singular value decomposition; the QR-factorization; and the use of phase portraits for dynamical systems. Avoidance of the 'wall of vector spaces'. Early, strong introduction to linear transformation. This becomes an underlying theme of the text. All chapters have some theory. More and better problems and exercises than in any other linear algebra text. After Eigenvalue chapter, a running theme in applying dynamical systems. Extensive historical references throughout.

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