

# Introduction to Matrices for Engineers\*

C.T.J. Dodson, School of Mathematics, Manchester University

## 1 What is a Matrix?

A matrix is a rectangular array of elements, usually numbers, e.g.

$$\begin{pmatrix} 1 & 3 & 0 \\ -2 & 8 & 2 \\ 4 & 0 & -1 \\ \frac{1}{2} & 0 & 117 \end{pmatrix}$$

The above matrix is a  $(4 \times 3)$ -matrix, i.e. it has three columns and four rows.

### 1.1 Why use Matrices?

We use matrices in mathematics and engineering because often we need to deal with several variables at once—eg the coordinates of a point in the plane are written  $(x, y)$  or in space as  $(x, y, z)$  and these are often written as column matrices in the form:

$$\begin{pmatrix} x \\ y \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

It turns out that many operations that are needed to be performed on coordinates of points are **linear operations** and so can be organized in terms of rectangular arrays of numbers, matrices. Then we find that matrices themselves can under certain conditions be added, subtracted and multiplied so that there arises a whole new set of algebraic rules for their manipulation.

In general, an  $(n \times m)$ -matrix  $A$  looks like:

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} & \dots & a_{1,m-1} & a_{1,m} \\ a_{21} & a_{22} & a_{23} & \dots & a_{2,m-1} & a_{2,m} \\ a_{31} & a_{32} & a_{33} & \dots & a_{3,m-1} & a_{3,m} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ a_{n-1,1} & a_{n-1,2} & a_{n-1,3} & \dots & a_{n-1,m-1} & a_{n-1,m} \\ a_{n,1} & a_{n,2} & a_{n,3} & \dots & a_{n,m-1} & a_{n,m} \end{pmatrix}$$

Here, the entries are denoted  $a_{ij}$ ; e.g. in Example 4.1.1 we have  $a_{11} = 1$ ,  $a_{21} = 2$ , etc. Capital letters are usually used for the matrix itself.

### 1.2 Dimension

In the above matrix  $A$ , the numbers  $n$  and  $m$  are called the *dimensions* of  $A$ .

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\*Based on original lecture notes on matrices by Lewis Pinnic.

# Matrices For Engineers

**William Wallace Bell**



## **Matrices For Engineers:**

*Matrices for Engineers* Allan D. Kraus, 1987-01-01 In teaching elementary network theory engineering mechanics and vibration analysis it has been found that many students lack versatility in the manipulation of matrices and possess little or no foundation in the theory of matrices This book attempts to alleviate this situation either in a self study or classroom framework The approach here is to provide the necessary material in a direct manner in most cases without rigorous proofs and derivations because it is believed that the proof is often formidable and tends to obstruct rather than aid the learning process Numerous examples are provided to illustrate each concept as it appears

**Matrix Operations for Engineers and Scientists** Alan Jeffrey, 2010-09-05 Engineers and scientists need to have an introduction to the basics of linear algebra in a context they understand Computer algebra systems make the manipulation of matrices and the determination of their properties a simple matter and in practical applications such software is often essential However using this tool when learning about matrices without first gaining a proper understanding of the underlying theory limits the ability to use matrices and to apply them to new problems This book explains matrices in the detail required by engineering or science students and it discusses linear systems of ordinary differential equations These students require a straightforward introduction to linear algebra illustrated by applications to which they can relate It caters of the needs of undergraduate engineers in all disciplines and provides considerable detail where it is likely to be helpful According to the author the best way to understand the theory of matrices is by working simple exercises designed to emphasize the theory that at the same time avoid distractions caused by unnecessary numerical calculations Hence examples and exercises in this book have been constructed in such a way that wherever calculations are necessary they are straightforward For example when a characteristic equation occurs its roots the eigenvalues of a matrix can be found by inspection The author of this book is Alan Jeffrey Emeritus Professor of mathematics at the University of Newcastle upon Tyne He has given courses on engineering mathematics at UK and US Universities

Matrix Algebra for Engineers James M. Gere, William Weaver, 1965

**Matrices for Scientists and Engineers** William Wallace Bell, 1975

Matrix Analysis for Scientists and Engineers Alan J. Laub, 2005-01-01 *Matrix Analysis for Scientists and Engineers* provides a blend of undergraduate and graduate level topics in matrix theory and linear algebra that relieves instructors of the burden of reviewing such material in subsequent courses that depend heavily on the language of matrices Consequently the text provides an often needed bridge between undergraduate level matrix theory and linear algebra and the level of matrix analysis required for graduate level study and research The text is sufficiently compact that the material can be taught comfortably in a one quarter or one semester course Throughout the book the author emphasizes the concept of matrix factorization to provide a foundation for a later course in numerical linear algebra The author addresses connections to differential and difference equations as well as to linear system theory and encourages instructors to augment these examples with other applications of their own choosing

Advanced Linear

Algebra for Engineers with MATLAB Sohail A. Dianat, Sohail Dianat, Eli Saber, 2017-12-19 Arming readers with both theoretical and practical knowledge Advanced Linear Algebra for Engineers with MATLAB provides real life problems that readers can use to model and solve engineering and scientific problems in fields ranging from signal processing and communications to electromagnetics and social and health sciences Facilitating a unique understanding of rapidly evolving linear algebra and matrix methods this book Outlines the basic concepts and definitions behind matrices matrix algebra elementary matrix operations and matrix partitions describing their potential use in signal and image processing applications Introduces concepts of determinants inverses and their use in solving linear equations that result from electrical and mechanical type systems Presents special matrices linear vector spaces and fundamental principles of orthogonality using an appropriate blend of abstract and concrete examples and then discussing associated applications to enhance readers visualization of presented concepts Discusses linear operators eigenvalues and eigenvectors and explores their use in matrix diagonalization and singular value decomposition Extends presented concepts to define matrix polynomials and compute functions using several well known methods such as Sylvester s expansion and Cayley Hamilton Introduces state space analysis and modeling techniques for discrete and continuous linear systems and explores applications in control and electromechanical systems to provide a complete solution for the state space equation Shows readers how to solve engineering problems using least square weighted least square and total least square techniques Offers a rich selection of exercises and MATLAB assignments that build a platform to enhance readers understanding of the material Striking the appropriate balance between theory and real life applications this book provides both advanced students and professionals in the field with a valuable reference that they will continually consult Matrix Methods for Engineering Louis Albert Pipes, 1963 *Matrices in Engineering Problems* Marvin J. Tobias, 2011 This book is intended as an undergraduate text introducing matrix methods as they relate to engineering problems It begins with the fundamentals of mathematics of matrices and determinants Matrix inversion is discussed with an introduction of the well known reduction methods Equation sets are viewed as vector transformations and the conditions of their solvability are explored Orthogonal matrices are introduced with examples showing application to many problems requiring three dimensional thinking The angular velocity matrix is shown to emerge from the differentiation of the 3 D orthogonal matrix leading to the discussion of particle and rigid body dynamics The book continues with the eigenvalue problem and its application to multi variable vibrations Because the eigenvalue problem requires some operations with polynomials a separate discussion of these is given in an appendix The example of the vibrating string is given with a comparison of the matrix analysis to the continuous solution Table of Contents Matrix Fundamentals Determinants Matrix Inversion Linear Simultaneous Equation Sets Orthogonal Transforms Matrix Eigenvalue Analysis Matrix Analysis of Vibrating Systems Matrix Computation for Engineers and Scientists Alan Jennings, 1992 **Journal - Society of Engineers** Society of Engineers (London, England), 1900 **Matrix Algebra**

**Handbook for Electrical Engineers** E. E. George, 1958      **Engineering Experiment Station Series** Virginia Engineering Experiment Station, 1923      **Transactions of the American Society of Mechanical Engineers** American Society of Mechanical Engineers, 1929 Vols 2 4 11 62 68 include the Society's Membership list v 55 80 include the Journal of applied mechanics also issued separately as contributions from the Society's Applied Mechanics Division      **Society of Engineers, London** Society of Engineers (London, England), 1900      System notion and engineering of systems Alain Faisandier,      **Engineering Experiment Station Series Bulletin** Virginia Engineering Experiment Station, 1923  
    **Engineering Experiment Station Series** Virginia Polytechnic Institute. Engineering Experiment Station, 1923  
    **Linear Algebra: Determinants and Eigenvalues** N.B. Singh, Linear Algebra Determinants and Eigenvalues is a comprehensive guide designed for absolute beginners offering a clear and detailed introduction to the fundamental concepts of linear algebra Focusing on determinants and eigenvalues the book explores their definitions properties and practical applications Through step by step explanations numerous examples and practical exercises readers will build a solid foundation in these essential topics This book is ideal for students and enthusiasts eager to understand the basics of linear algebra and its significance in various fields such as engineering physics computer science and economics      Engineering, 1889      Matrix Algebra for Engineers James Monroe Gere, William Weaver, 1968

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