

# Introduction to Matrices for Engineers\*

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## 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

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

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  $a_{11} = 1$ ,  $a_{23} = 2$ , 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 Pimble.

# Matrices For Engineers

**Kwong-Tin Tang**



## Matrices For Engineers:

**Matrix Algebra for Engineers** James M. Gere, William Weaver, 1965      **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      Matrices for Engineers Allan D. Kraus, 1988 Matrices for Engineers is designed to supply engineers and engineering students with a foundation in matrix theory and versatility in the manipulation of matrices The book s approach provides the necessary material in a direct manner with examples that illustrate each concept as it appears The book emphasizes methodology and includes topics such as how to obtain the characteristic polynomial of a matrix the factorizations of a coefficient matrix for ease of computation and linear transformations from an intuitive and engineering point of view in which conditions at one point in a system induce conditions at another Indeed it covers computational techniques and goes beyond matrix algebra to include matrix calculus Perfect for self study Matrices for Engineers also functions as a supplement to Oxford University Press s popular Linear Circuit Analysis Second Edition 0 19 513666 7 by Raymond A DeCarlo and Pen Min Lin or any introductory electrical engineering text such as Introduction to Electrical Engineering 0 19 513604 7 by Mulukutla S Sarma It can also be used to help in preparing for the Fundamentals of Engineering FE Engineer in Training EIT exam and the Professional Engineer PE exam For a complete and detailed list of engineering exam review books available from Oxford University Press visit our website at <http://www.engineeringpress.com> Also Available from Oxford University Press DeCarlo and Lin s Linear Circuit Analysis Second Edition 0 19 513666 7 Allan s Circuits Problems by Allan D Kraus 0 19 514248 9 Solutions Manual to Accompany Linear Circuit Analysis Second Edition by Raymond A DeCarlo and Pen Min Lin 0 19 514218 7 Microsoft PowerPoint Overheads to Accompany Linear Circuit Analysis

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both advanced students and professionals in the field with a valuable reference that they will continually consult **Matrix Algebra for Engineers** James Monroe Gere, William Weaver, 1968 Linear Algebra Arak M. Mathai, Hans J. Haubold, 2017-10-23 In order not to intimidate students by a too abstract approach this textbook on linear algebra is written to be easy to digest by non mathematicians It introduces the concepts of vector spaces and mappings between them without dwelling on statements such as theorems and proofs too much It is also designed to be self contained so no other material is required for an understanding of the topics covered As the basis for courses on space and atmospheric science remote sensing geographic information systems meteorology climate and satellite communications at UN affiliated regional centers various applications of the formal theory are discussed as well These include differential equations statistics optimization and some engineering motivated problems in physics Contents Vectors Matrices Determinants Eigenvalues and eigenvectors Some applications of matrices and determinants Matrix series and additional properties of matrices Matrices in Engineering Problems Marvin Tobias, 2022-06-01 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 **A Course In Vector And Matrix Analysis For Engineers And Physicists** A.K. Mukhopadhyay, S. Sengupta, 2010-02-01 With the advancement of technology and general science the applications of Mathematics becoming more and more extensive requiring on in depth knowledge of different mathematical tools This volume introduces students of Engineering and Physics to those areas of Mathematics which from a modern point of view seem to be very important in connection with practical problems Almost all the chapters contained in the book deal with various aspects and applications of vector and matrices The applications have established them as important tools for solving physical and engineering systems **Matrix Methods for Engineers and Scientists** Stephen Barnett, 1979 **Mathematical Methods for Engineers and Scientists 1** Kwong-Tin Tang, 2022-10-25 The topics of this set of student oriented books are presented in a discursive style that is readable and easy to follow Numerous clearly stated completely worked out examples together with carefully selected problem sets with

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