BOOK REVIEW

Introduction to Linear Algebra (2nd Edition)

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In the preface to "Introduction to Linear Algebra," the authors stress the importance of the book's subject matter as a component of undergraduate mathematics particularly for scientific, engineering and social science undergraduates. This book is a carefully planned and well presented text book on linear algebra. Containing 7 chapters and almost 600 pages, it strives to approach the subject at two levels. At the practical level, matrix theory and the related vector-space concepts provide a language and a powerful computational framework for posing and solving important problems. Beyond the practical level, its treatment of the subject contains a valuable introduction to mathematical abstraction and logical development.

It is at this practical level that the book is particularly attractive. It contains a variety of (optional) applications in the first

three (core) chapters. In addition, the final chapter (Chapter 7) gives a reasonable treatment of a selection of numerical methods in linear algebra and includes Gaussian elimination, the power and inverse power methods for eigenvalue problems, reduction to Hessenberg form and estimation of the eigenvalues of Hessenberg matrices. This "mix" of theory, applications and numerical methods makes the book a very attractive proposition for students taking both elementary and advanced modules in linear algebra as well as a basic course in numerical linear algebra. In the latter case, there is the added attraction of having a range of FORTRAN programs listed in the final chapter.

Chapter 1, entitled *Matrices and Linear Equations* contains a standard but well-presented exposition of Gaussian elimination and matrix algebra. However, it is refreshing to note that the chapter contains a number of illustrating applications. These include the use of matrix methods in data fitting (polynomial interpolation), numerical integration and differentiation.

Chapter 2, *The Vector Space,* R^n provides an introduction to vector-space ideas (subspace, basis, dimension, etc.) in the familiar setting of R^n. In this chapter, the applications include the least-squares problem in R^n, data fitting and least-squares solutions of overdetermined linear systems.

Because of the two-level approach adopted by the authors, certain material such as that in Chapter 3, *The Eigenvalue Problem*, is revisited and considered in greater depth in later chapters. For example, there is a necessity to provide a brief introduction to determinants in Chapter 3 to facilitate the early treatment of eigenvalues but a more complete treatment of determinants (even repeating some of the earlier discussion) is given in Chapter 5. Chapter 3 also contains some (optional) applications. These include difference equations and Markov Chains.

Chapters 4, *Vector Spaces and Linear Transformations* and 5, *Determinants*, follow along traditional lines. For example, the former concentrates on vector spaces and subspaces, linear independence and bases, inner product spaces, linear transformations and their matrix representations. However, this is more than just a traditional approach. The topics are organized so that they flow logically and naturally from the concrete and computational to the more abstract. There is also a wealth of examples to enable the student to gain even further insight into the various concepts.

Chapter 6, *Eigenvalues and Applications*, begins with an introduction to quadratic forms and this is followed, using the treatment of eigenvalues from Chapter 3, by a review of systems of differential equations. The remainder of the chapter is devoted to Hessenberg matrices, Householder transformations, the QR factorization and least-squares solutions, matrix polynomials and the Cayley-Hamilton theorem. The final section considers generalized eigenvectors and solutions of systems of differential equations.

The final chapter, Chapter 7, *Numerical Methods in Linear Algebra*, the contents of which were mentioned earlier, is a welcome addition to a general text on Linear Algebra. If a foundation course on Numerical Linear Algebra is offered in conjunction with more theoretical modules, then this book is sufficiently self-contained for both aspects. The provision of listings of FORTRAN programs is also welcome in relieving the student from time consuming and error prone programming.

The authors advise that an instructor's manual and a student solutions manual are now available. The book itself contains solutions to all the odd-numbered computational exercises while the student solutions manual includes detailed solutions for these exercises. The instructor's manual contains solutions to all of the exercises.

I consider the book to be an attractive proposition for undergraduate training. There are a number of reasons why this is so. It provides a gradual increase in the level of abstraction, it contains an early introduction to eigenvalues. The first three chapters could themselves constitute a core (single-term) module on linear algebra at first or second year undergraduate level.

At all levels in the book, the material is presented very clearly and it is augmented continuously by numerous examples and, in particular sections, by applications of very general appeal. The exercise sets are themselves graduated (or spiralling) and many sections contain exercises that hint at ideas which are developed later in the text. The inclusion of computer awareness and reliable computer programs provide the numerical flavour which, in my opinion, enhances the appeal of a text book on one of the most important components of undergraduate mathematics in our third level colleges.

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