NUCLEAR SCIENCE AND ENGINEERING: 26, 578-579 (1966)

Book Reviews

Iterative Solution of Elliptic Systems and Application to the Neutron Diffusion Equations of Reactor Physics. By Eugene L. Wachspress. Prentice-Hall, Inc., Englewood Cliffs, N. J. 299 pp. $12.95.

For quite some time, concern has been expressed about the gap that exists, and seems to be widening, between the physicist or engineer who has a problem to be solved and the techniques to be used for the problem solution. With the development of more sophisticated numerical methods, a chasm could develop were it not for books such as this one by E. L. Wachspress. An expert may also profit from his book.

Contents of the nine chapters may be briefly summarized as follows:

Chapter 1 is devoted to an exposition of subsequently used matrix concepts and facts. Possible methods of solution of linear systems of equations are also discussed.

Boundary value problems for second-order partial differential equations are examined and classified in Chap. 2. Several methods of discretization of the equations are exhibited, among them a discretization based on variational techniques. The stability and convergence of numerical procedures used to solve the discretized problem are examined.

Chapter 3 is a discussion of the group diffusion equations of reactor pnysics. The mathematical properties of these equations as consequences of physical laws are established. This leads to proof of existence of a greatest real eigenvalue and unique positive eigenvector (solution) for both the continuous and discretized equations. Further, the concepts of inner and outer iteration to obtain the neutron flux by iterative methods are introduced.

The successive over-relaxation (SOR) iteration schemes for solving linear systems of equations are the subject of Chap. 4. Questions of rate of convergence as affected by the form and eigenvalues of the coefficient matrix, relaxation parameter, point, line and block relaxation methods, and the selection of a relaxation parameter are studied.

Chapter 5 is concerned with the use of residual polynomials in extrapolation procedures. The Lanczos and Chebyshev methods are described. The remainder contains the use of Chebyshev extrapolation with SOR, and the construction of eigenvectors from residual polynomials.

Alternating-direction-implicit iteration (ADI) techniques constitute Chap. 6. These ADI techniques are shown to be quite efficient when combined with Lanczos-type iteration or Chebyshev extrapolation to form a "compound" iteration. Computation strategy for ADI and for compound type, and optimum parameters for this latter type are determined.

Chapter 7 examines the problem of finding a positive eigenvector corresponding to the largest eigenvalue of a given matrix. This problem reflects upon the relationship between the number of inner iterations per outer iteration for neutron diffusion problems.

In Chapter 8 the methods of Chaps. 4 through 6 are compared by actual computation of various problem solutions.

Chapter 9 explores a method for accelerating convergence based on variational techniques. By proper partitioning, the problem may be reduced to the direct solution of a series of smaller problems.

This clearly written and well-organized book is certainly worthwhile for anyone using computers for large problems such as reactor physics computations. If something bad has to be said, it would have been preferable if the fission source term in the diffusion equation had been written as

$$\frac{\chi_g}{\lambda_0} \sum_{g'} (\nu\Sigma_f)_{g'}(r)\phi_{g'}(r)$$

instead of

$$\frac{\nu\chi_g}{\lambda_0} \sum_{g'} \Sigma_{f,g'}(r)\phi_{g'}(r),$$

and the few misprints had been avoided.

Harold Greenspan

Argonne National Laboratory
Argonne, Illinois

June 27, 1966

About the Reviewer: Harold Greenspan is an Associate Mathematician in the Applied Mathematics Division of Argonne National Laboratory. At Argonne since 1949, he has been active in reactor mathematics and reactor code development. In his connection with the Reactor Physics Constants Center he served as coauthor of the Chapter on Nuclear Codes in ANL-5800 (rev).

The Safe Transport of Radioactive Materials. Edited by R. Gibson, Pergamon Press, New York (1966). 279 pp. $12.50.

It is a challenge to briefly review this book about a book (*IAEA Regulations for the Safe Transport of Radioactive Materials, 1964 Revised Edition*) that succeeds a book (the Agency regulations of 1961). To the US reader who may not be familiar with the IAEA regulations, it should be mentioned that their principal features are similar to those of recently issued 10 CFR Part 71 and AEC Manual Chapter 0529. This is no accident, for two-way influence has led to the common aspects: the classification of radioisotopes; the three classes of packages for fissile material; the package criteria (performance and associated contents); and the control of certain shipments by "transport index." We must assume some familiarity with these features to avoid another book about. . . .

The 21 authors of *The Safe Transport of Radioactive Materials* are contributors to the IAEA regulations and to