Check for updates

journal of dynamic systems, measurement, and control

book reviews

FINITE ELEMENT ANALYSIS IN FLUID DYNAMICS, by T. J. Chung, McGraw-Hill, 1978, 378 pages.

REVIEWED BY D. M. KUZO[1]

For most purposes, finite elements and finite differences are the widely used numerical approximation techniques for differential equations. The reviewed book is designed to be an operational text for the engineer or scientist desiring numerical solutions. Originating from lecture notes at the graduate level, the reviewed book serves purpose in three areas:

(*a*) It introduces the finite element technique.
(*b*) It gives an overview of the state of finite element techniques in fluid mechanics.
(*c*) It provides the background base for advanced uses of finite elements.

Almost to the page, the book is evenly divided between technique and example. Beginning with the tools of index and matrix notation, divergence theorem, and functional analysis, the author adequately details two solution procedures: Rayleigh-Ritz and Galerkin. Both techniques require the approximation of the solution space by a finite N-dimensional function space. The Rayleigh-Ritz technique seeks to stationarize the functional of the system with respect to N-constants, whereas Galerkin minimizes the inner function product (i.e. the integral) of the approximation error and the N approximating functions. The author includes functional analysis for those desiring a rigorous error analysis, while advising the novice to skip this section. Although not a textbook *per se*, before concluding chapter one, the author presents a one-dimensional example done to such an explicit degree, that it can be followed by those uninitiated to numerical techniques. This assumes, of course, you are willing to accept discretation of the solution.

Throughout the book, the author conveniently points out references that can be used for further study.

Chapters two and three become the handbook reference for the examples in the second half. Explicitly displayed interpolation functions (lagrange and hermite) are detailed in one, two, and three dimensions. Stressed are the so-called "isoparametric" coordinates, which reduce the computational effort by allowing the same parametric relationships used for coordinates to be used for the unknown solution function. Chapter three details the solution of the finite element equation, including treatment of Dirichlet and Neumann boundary conditions.

Beginning with chapter four and continuing through chapter seven, the author quickly presents the required equations for fluid dynamic analysis, and proceeds with an adequate presentation of examples, mostly in two dimensions. The incompressible flow chapter includes examples of potential and viscous flow, wave motion, rotational and boundary layer flow. Although space requirements limit, the author tries to present for each problem the construction of the local equation along with boundary condition treatment. Although the greater flexibility of the Galerkin technique is pointed out numerous times, where possible the author includes a Raleigh-Ritz approach.

Chapter six includes compressible flow topics such as shock waves, and unsteady transonics. Chapter seven covers techniques for the diffusion equation, rarified gases, and MHD. Three Fortran listings of potential flow solutions in two and three dimensions are contained in the appendix.

The presentation of the chapters one through three allows this book to be used as an introduction to finite element techniques (in fluids or elsewhere). Difficulty should be expected, however, if the reader is not cognizant of the underlying philosophy of numerical approximation. Sadly lacking, from this engineer's view, is a description of how one must mathematically discretize an essentially continuous solution. A book, commencing with such elementary presentations and examples, should contain these explanations. However, due to this shortcoming, responsibility for filling the void falls upon the reader. If this book is to be used in the classroom, the instructor should review these mathematical approximations.

This book can also fill the needs of an engineer or scientist, already familiar with numerical techniques, who is desiring to acquaint himself with numerical fluid dynamics. However, those already involved in esoteric fluid computations, would be well-advised to seek reference elsewhere.

[1]Lehigh University, Bethlehem, Pa. 18015. Mem. ASME

Downloaded from http://asmedigitalcollection.asme.org/dynamicsystems/article-pdf/100/4/347/5528615/347_1.pdf by guest on 20 August 2022

Copyright © 1978 by ASME