Journal of Mechanical Design

Book Reviews

Elementary Finite Element Method. by C. S. Desai, Prentice-Hall, Englewood Cliffs, N.J., 1979. 434 pages, Price: $24.95

Reviewed by H. Saunders[1]

Finite elements become more sophisticated with the passing of time. Previously, finite elements (FE) concerned themselves with structural applications. Lately, FE applications have become more noticeable in other disciplines i.e., fluid mechanics, soil and rock mechanics, heat conduction, seepage, consolidation, stress wave propagation, and electromagnetic theory. At present, the previous youth (FE) has matured to a full-grown man.

The book is unique since the author attempts to discuss all of the foregoing topics in an elementary fashion. He performs a most admirable job in his undertaking.

Most books on elementary aspects of FE discuss structural mechanics of frames, rods, and beams but nary a mention of additional topics. The new fields in FE as stated above were originally founded on empirical techniques and finite difference methods. They now have a new partner in FE.

The introductory Chapters 1 and 2 supply the steps used in FE. With this under our belt, Chapter 3 considers one-dimensional stress and deformation. This includes relations between global and local coordinates, complementary energy approach, and formulations by Galerkin's method. The latter is usually never mentioned in elementary texts on FE.

Continuing further, Chapters 4-6 dwell upon one-dimensional flow, one-dimensional time dependent flow, and computer coding for the previous chapters. This latter feature is a definite plus, since computer programs are at the heart of the FE method.

We next encounter beam bending and beam columns. This subject is covered more deeply here than in a number of other FE books. Departing from structures, we now confront one-dimensional mass transport and channel flow. The latter is formulated by Galerkin's method.

Chapter 10 contains an introduction and derivation of one-dimensional stress wave propagation while Chapter 11 considers one- and two-dimensional torsion. This is a most exhilarating chapter, and boundary conditions are brought forth with clarity. The author uses computer solutions to explain the salient points of torsion of a square bar. The author further brings to our attention the use of hybrid approach. Here, one assumes displacements inside the element and stresses on the boundary, the latter meant to overcome some of the deficiencies of the usual FE approach. The chapter concludes with static condensation of an element. This is important when we are required to eliminate an interior mode.

Chapter 12 briefly considers potential, thermal, and fluid flow problems. Chapters 13 and 14 conclude the book with a brief mention of two-dimensional analysis and multi-component systems.

In summary, this is an excellent book for beginners as well as the more advanced person grounded in the knowledge of FE. This book is replete with good discussions and examples showing how FE can be used in practical problems. The reviewer would like to see an advanced treatise on FE written by the author in his inimitable style. I was highly impressed with the book. Bravo to the author for his well-written book!

An International Survey of Shock and Vibration Technology, edited by H. C. Pusey, R. H. Volin, J. G. Showalter, Shock and Vibration Information Center, Washington, D.C., 1979. Price: $60

Reviewed by H. Saunders

Are you in the midst of planning a vibration test or perhaps diagnosing the health of some vital manufacturing equipment? You would like to know what tests and analytical works were performed on a similar type of specimen or component. Furthermore you are not anxious to invent "new wheels" but would like to capitalize on the experience of previous experimenters or designers in this field. In all probability, you can be aided by referring to the various reports, papers, and technical information published within the past eight years.

This interesting report contains information on mathematical analysis of modeled engineering problems leading to computers, and analytical methods, including nonlinear and variational methods. Numerical methods spurred on by the digital computer encompasses both finite elements and finite differences and are the basic formulations required to solve shock and vibration problems. The latter topics or methods play important roles in supplementing and extending shock and vibration information.

This book contains a very broad survey of the shock and vibration technology from an international standpoint. More then 7000 abstracts from the years 1971-9 were scanned from

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the most important countries except those behind the Iron Curtain.

The book is further subdivided into a number of subjects with the uppermost thought concerning their connection with shock and vibration. Environments including acoustics or noise (aircraft, vehicle, community, machinery, and industrial) are considered from the standpoint of utility to the design or research engineer in obtaining important findings. Shock, sonic boom, explosive shock, and seismic response are all considered in a similar manner.

Delving further, damped structures in their various forms play a major role in structural response. As structures become more flexible and hard-pressed for increased efficiency, damping becomes an important contributor to response determination (analytical and experimental).

The advent of more sophisticated experimentation requires greater emphasis to be placed upon measurement analysis, of dynamic testing, diagnostic methods, sealing, and modeling. Previously, simple analog traces were sufficient. The more modern FFT instruments, holographic methods and multi-recording equipment are now commonplace. Diagnostics comes of age by utilizing "signature analysis" for machinery health purposes. Model analysis in its new garb, i.e., structural testing, ushers in a new era.

Fluid-structure interactions including flow-induced vibration becomes more viable. It appears in heat exchangers, aircraft, and wind-induced oscillations of buildings. Random or stochastic processes go hand in hand with fluid-structural interactions.

Components including electrical, mechanical (bearings, linkages, gears, blades, and valves) and structural (beams, cables, cylinders, shells, frames, membranes, panels and rings) can be more easily analyzed by use of the latest experimental and analytical tools.

Taking the great step forward from components to systems requires greater versatility of combined analysis and equipment usage. Due to stringent requirements of various government boards, higher performance demands for large systems (reactors, ground-air-underseas vehicles) have made full-scale tests more important. This now requires better planning plus use of more sophisticated types of testing and recording instrumentation.

In summary, this book is an important asset in the dynamic fields of shock and vibration. Since it contains the vast and important references to tests and method of analysis, it should be placed in a prominent location to provide direct help to the designer, experimenter, and researcher.

The book's major drawback is the exclusion of material from the Iron Curtain countries. Including the research from these countries would enhance the value of this book. The reviewer has been told that the editors are continually reviewing references from 1979 to the present. He recommends that a supplement should be considered including latest references and Iron Curtain country materials. This book should be of interest to engineers and scientists engaged in shock, vibration and allied studies. The authors have done an excellent job.