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book reviews

Direct Variational Methods and Eigenvalue Problems in Engineering. By H. Leipholz. Noordhoff International Publishing, Leyden, The Netherlands. 1977. Pages viii + 246. Price $36.00.

REVIEWED BY S. H. CRANDALL[1]

The natural frequencies of small transverse vibration of a finite beam are governed by an eigenvalue problem. When the beam carries a distributed axial load, the axial load can be taken to remain unidirectional, independent of deformation, or it may be assumed to "follow" the deformation and act tangentially to the deflected beam. In the former case the axial load is conservative and the eigenvalue problem is self-adjoint while in the latter case the load is nonconservative and the eigenvalue problem is nonself-adjoint. If the axial load is increased the unbent configuration eventually becomes unstable. In the conservative case the loss of stability is always by buckling (i.e., divergence) while in the nonconservative case it can be by buckling if the beam is supported at both ends or it can be by oscillations of fixed frequency and increasing amplitude (i.e., flutter) if the beam has a free end. In both cases approximate solutions to the eigenvalue problem can be obtained by applying direct variational methods usually associated with the names of Rayleigh, Ritz, and Galerkin.

The present book represents the results of the author's investigations into the problem of proving convergence of Galerkin's method when applied to follower-force systems. Extensions of the Ritz and Galerkin methods are established for follower-force systems which preserve the well-known interrelationships that these methods have for conservative systems. The central contributions of the book are careful detailed proofs of the convergence of these methods, first for conservative systems, and then for follower-force systems. In addition convergence is also discussed for some related methods (method of moments, harmonic balance method, Grammel's method, and Trefftz's method) and for hybrid Ritz and Galerkin methods based on simultaneous treatment of the given system and its adjoint. Although most developments are framed in terms of the beam problem there is an abstract generalization of the problem formulation including brief discussions of the corresponding eigenvalue problems for plates and shells.

The book will be of interest to applied mathematicians and others interested in convergence proofs. Engineers may be troubled by the absence of any discussion of what physical phenomena can be modeled by follower forces. The book is apparently a literal translation of a German edition published in 1975 by Verlag G. Braun, Karlsruhe. The words are English but in many places the syntax and grammar remain German.

Application of Elastic Waves in Electrical Devices, Nondestructive Testing, and Seismology. Report of a Workshop held at Northwestern University, May 24–26, 1976. Supported by the National Science Foundation, Engineering Mechanics Section, Solid Mechanics Program. Pages ii + 599. Copies available from Professor J. D. Achenbach, Department of Civil Engineering, Northwestern University, Evanston, Ill. 60201

REVIEWED BY S. H. CRANDALL[1]

The theory of wave propagation in elastic media has been developed and applied in many fields of science and engineering since it was employed in the 19th century to explain optical phenomena under the assumption that light was propagated through an elastic "aether." Although the basic theory remains invariant the problems and techniques of interest in different fields have tended to become specialized and parochial so that it now takes a special effort for a worker in one field to inform himself on the progress of his colleagues in another field. In May, 1976, the National Science Foundation supported such an effort for some 80 workers from four fields: applied mechanics, electrical devices, nondestructive testing, and seismology. The workshop, organized by J. D. Achenbach, Y. H. Pao, and H. F. Tiersten, consisted of 22 formal presentations, divided more or less equally between applications to electrical devices (crystal oscillators and surface-acoustic-wave devices), to nondestructive evaluation (ultrasonic imaging and acoustic emission), and to seismology (seismic sources, crack propagation, and data processing), together with the informal discussions which followed each presentation. The present volume contains the manuscripts of the papers, a record of the discussions, and a summary report. These proceedings should be of particular interest to a worker in elastic wave propagation with a background in applied mechanics who wants to orient himself with respect to practical problems in the three fields covered. Copies of the report can be obtained by writing to Professor Achenbach.

Stability of Fluid Motions—I. By Daniel D. Joseph. Springer-Verlag, New York. 1976. Cost $39.80.

REVIEWED BY R. C. DiPRIMA[2]

This is the first volume of an important two-volume contribution to the subject of hydrodynamic stability. Readers familiar with the classic monographs, "The Theory of Hydrodynamic Stability" by C. C. Lin in 1955 and "Hydrodynamic and Hydromagnetic Stability" by S. Chandrasekhar in 1961, will find the present work to be of a considerably different nature. In these monographs, the emphasis was on the mathematical detail in solving the linearized disturbance equations for infinitesimal disturbances to simple basic fluid flows such as Couette flow, plane Poiseuille flow, nearly parallel boundary layer flow, a layer of fluid heated below, and various generalizations of these flows.

Since the Lin and Chandrasekhar volumes were written, mathematical theories have been developed to take account of nonlinear effects (at least in a limited way) and noninfinitesimal disturbances. One can readily see three nonexclusive lines of research in the literature which can be roughly characterized as (*i*) the analysis of specific hydrodynamic stability problems and/or the corresponding development of mathematical techniques for calculating flows which have their origin in the Stuart-Watson papers in 1960, the calculation of Taylor-vortex flow between concentric rotating cylinders by Davey in 1962 following the method of Stuart-Watson, and the finite amplitude calculation of cellular convection by Malkus and Veronis in 1958; (*ii*) energy methods for determining global stability limits for flows and stability limits for specific disturbances of arbitrary magnitude which received a major impetus from the work of Serrin in 1959 and the author of the present monograph; and (*iii*) the more abstract

[1] Ford Professor of Engineering, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

[2] Professor, Department of Mathematical Sciences, Rensselaer Polytechnic Institute, Troy, N. Y.