extension to three dimensions is mentioned. Chapter 3 returns to the assembly procedure for the global data and the constraints for the essential boundary conditions. Gauss elimination and triangular factoring are presented as suitable direct methods for the solution of the global stiffness equation. Iterative methods are also briefly mentioned. Greater attention is paid to static-condensation and substructuring in the elimination process. Chapter 4 enlarges upon the subject to Chapter 3 and considers the Gauss elimination technique in the case the global stiffness matrix is stored in-core in a band form. Substructuring is then used to introduce the front solution method that operates with element data. Elimination is further considered for matrices where only the envelope is stored in a one-dimensional array. Chapter 5 is devoted to the application of the finite-element method to three-dimensional elasticity. Chapter 6 extends the finite-element discussion to higher-order, curvilinear, two and three-dimensional elements, and the inevitable numerical integration. Chapter 7 deals with bending (biharmonic) problems and their finite-element solution. Chapter 8 introduces the Hybrid method. Chapter 9 very briefly discusses dynamical, singular and nonlinear problems. An Appendix reviews matrix algebra and calculus of variations.

It is surprising that the authors did not see fit to include even the most elementary theoretical justification for the techniques they present to the student. No distinction is made between minimal and indefinite variational principles and the fundamental bearing this has on stability and convergence. The unaware student might go away from this book with the impression that a variational principle is somehow all that is needed to justify, and safely use, a corresponding finite-element method like the Hybrid—but if so, he is deadly mistaken.

Energy Methods in Stress Analysis With an Introduction to Finite-Element Techniques. By T. H. Richards. Halsted Press, a Division of John Wiley & Sons, Inc. 1978. Pages 500. Price $47.50.

REVIEWED BY T. J. LARDNER[4]

The aim of this senior undergraduate and first year graduate level text is to develop energy principles for application to equilibrium stress and deformation problems. The author starts with a review of statics, emphasizing the principles of virtual work and complementary virtual work and the principles of potential and complementary energy. Not many engineering students in the United States will have had this material in a Statics course; the importance of this fundamental material to what follows is emphasized.

The following list of chapter headings provides a quick overview of the contents of the text: Basic Principles of Statics; Bar Type Systems; Principles of Solid Continuum Mechanics (Introduction to Linear Elasticity); Variational Calculus—Principles; Variational Calculus—Direct Methods (Rayleigh-Ritz, Kantorovitch, Galerkin, Trefftz Methods); Variational Principles in Solid Continuum Mechanics (Applications to Beams and Plates); Applications of the Direct Methods of the Calculus of Variations (Beams, Torsion, Plates); The Finite-Element Method (Displacement Method, Bar Extension and Flexure, Plane Frames, Plane Stress, Torsion, Mixed Formulations). There are numerous examples and problems with each chapter.

The author has attempted to present the material from ". . . the treatment of discrete rigid body/spring systems onto bar and more sophisticated continuum stressing situations culminating in an introduction to the finite element method." He has done a good job and the text can be recommended for an introductory course in Applied Elasticity or Stress Analysis.

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Catastrophe Theory and Its Applications. By T. Poston and I. Stewart. Fearon-Pitman Publishers, Inc., Belmont, Calif. 1978. Pages vii–491. Price $49.75.

REVIEWED BY R. H. PLAUT[5]

Catastrophe theory has spread throughout the scientific community during the past few years. In applied mechanics, papers which incorporate this theory have appeared with increasing frequency. A conference devoted to "The Application of Catastrophe Theory in Mechanics" was held by the Society for Natural Philosophy in 1978. The ideas of catastrophe theory are indeed intriguing and worthy of attention. For those who have not yet studied catastrophe theory but desire to do so, this book by Poston and Stewart is highly recommended.

The book is written especially for physical scientists. Some of the most sophisticated and lengthy mathematical proofs in the theory are left out. The conversational tone used by the authors makes the book very readable, and the excellent illustrations are extremely helpful to the presentation of the material.

Catastrophe theory deals with systems which can exhibit sudden changes in behavior while their parameters are varying slowly. The theory can furnish insight into the various possible types of behavior of a system. It can provide a new outlook on problems, inducing one to visualize them from a different perspective. The authors demonstrate that quantitative results can be obtained, as well as qualitative ones, and that the concepts can be applied to a tremendous variety of phenomena.

The first nine chapters, covering 193 pages, develop the mathematical theory. Topics in multidimensional geometry and calculus are discussed first. The Splitting Lemma is then proved, which allows one to reduce the investigation to a certain number of essential variables. The concepts of structural stability, transversality, determinacy, and unfoldings are introduced, Thom's classification theorem is presented, and the geometrical structures of the first seven catastrophes are described.

In the second part of the book, the reader is introduced to some of the problems to which catastrophe theory has been applied. They include the following: (*a*) the stability of static equilibrium states of ships and oil-rigs; (*b*) streamline patterns in two-dimensional steady fluid flow; (*c*) problems in classical ray optics, scattering theory, and wave optics, including discussions of rainbows, mirages, sonic booms, and giant ocean waves; (*d*) static buckling of elastic columns, arches, and plates; (*e*) thermodynamics and phase transitions; (*f*) analysis of lasers as catastrophes, and a comparison between theoretical and experimental results; (*g*) the size and distribution of species, and some questions in embryology; and (*h*) some applications in the social sciences. Finally, an extensive bibliography of works on catastrophe theory is presented.

With all the recent publicity and controversy (and perhaps mystery) regarding catastrophe theory, this book by Poston and Stewart is certainly welcome. It explains the mathematical theory in a systematic and readable manner, and gives a sampling of applications in the physical sciences. For those who wish to delve into the subject, this book is the place to start.

Modern Problems in Elastic Wave Propagation. Edited by J. Miklowitz and J. D. Achenbach. Wiley-Interscience. 1978. Pages x–561. Price $32.50.

REVIEWED BY R. A. SCOTT[6]

An IUTAM Symposium on modern problems in elastic wave

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propagation was held at Northwestern University in 1977. This book presents the results of that Symposium. It contains 25 papers, divided into six parts, and some brief abstracts (which will not be considered here.)

Part one is devoted to methods. Dynamic photoelasticity is reviewed by Dally and other experimental techniques are described by Beinert, with emphasis on shadow-optical, schlierenoptical, interferometric, and fractographic methods. The major emphasis in a paper of Aboudi is on finite-difference techniques, a wide range of problems being covered. Finite-element schemes are reviewed by Belytschko and Mullen, and developments of differential transform techniques are given by Ungar. Use of Padé approximants for inhomogeneous media is treated by Mainardi, Servizi, and Turchetti.

Part two involves diffraction and scattering. The powerful transmission matrix method is described by Pao. Scheidl and Ziegler give a Fourier series type of solution for the scattering of Rayleigh waves by a buried inclusion. Studies involving matched asymptotic expansions are presented by Viswanathan and Sharma, and Datta and El-Akily. Ray theory is employed by Achenbach, Gautesen, and McMaken to analyze diffraction by cracks and Regge pole techniques are introduced by Überall. Inverse acoustic problems for layered media are discussed by Nigul and Engelbrecht.

Anisotropic and inhomogneous media are the topics of part three. Recent developments in plane wave propagation are described by Musgrave. Lamb's problem for a laminated composite is treated by Sve and Miklowitz, using an effective stiffness theory. Propagation in inhomogeneous media of a special type is discussed by Rao.

Waveguides are considered in part four. Generalized ray techniques for anisotropic waveguides are developed by Willis and Bedding. A solution to the nonseparable problem of a cantilever plate excited by base motion is presented by Miklowitz and Garrott. A survey of propagation in rods is given by Keller.

Surface waves are treated in part five. Vlaar and Nolet review developments in seismic surface wave theory. Questions regarding the existence of surface waves in anisotropic media are resolved by Barnett and Lothe. A new type of surface wave in laminated composites is detailed by Auld, Beaupre, and Herrmann.

Problem of special interest in seismology are examined in part six. Four different techniques for generating synthetic seismograms are discussed by Chapman, and Helmberger and Harkrider give an account of the use of generalized ray theory in seismology. Mode shapes and frequencies for several physical problems are determined by Sato, with a view toward constructing synthetic seismograms.

The reviewer wishes that the technical discussions could have been incorporated into the text. Despite this minor drawback, the book is a must for the reference shelf of researchers in elastic waves.