problems by various methods. An appendix discusses finite element methods. The chapter on applications in classical mechanics and elasticity is almost too comprehensive. He discusses least action, Hamilton's principle, as well as all of the standard variational principles of infinitesimal elastostatics, elastodynamics, and finite elastostatics. Several examples are given. The chapter on heat conduction is likewise very complete. He discusses the stationary equations, both linear and nonlinear, the nonstationary linear equations, both the standard parabolic equations and the hyperbolic equations, and finally several results for nonstationary nonlinear theory. The chapter on coupled thermoelasticity skims over several variational principles from the recent literature. This set of notes could easily form a text for a graduate engineering course, as the presentation is very concise and thorough.

Instabilities and Catastrophes in Science and Engineering. By J. M. T. Thompson. Wiley, New York, 1982. pp. xvi–226. Price $34.95.

REVIEWED BY H. H. E. LEIPHOLZ[3]

The author of this book is a well-known expert in the field of stability of mechanical systems. Therefore, in writing this work, he was able to draw a wealth of facts and examples from his previous research. Yet, having pursued the development of stability theory in general, i.e., in mathematics and science, and having studied most recent results, for example, in the context of catastrophy theory, he was able to add important results coming from other branches of science to his results in engineering, so that the book has become a broad, most impressive, and stimulating survey of modern stability theory. Should anybody, student or even experienced specialist, like to have a fascinating introduction into the state of the art, the ramifications of stability theory, a hint on the new and promising onset of further development, and a survey on present applications of stability theory to various problems in a set of most diverse fields of engineering and science, he should read this book.

In spite of its broad scope, the book is written sufficiently rigorously so as to satisfy the specialist, and at the same time, sufficiently challenging so as to attract any reader to areas described in the book that should be new to him.

Some of the important modern topics dealt with in the book are: catastrophe theory, stability of nonconservative systems, dynamics of a strange attractor, etc. Fields of applications touched on are: structural engineering, astrophysics, nuclear physics, biochemistry, ecology, hydrodynamics, space mechanics, and neurology. The book is highly recommended to anybody interested in instability phenomena and stability theory.

Mechanics of Brittle Fracture. By G. P. Cherepanov. (Translation by A. L. Peabody, edited by R. DeWit and W. C. Cooley, from the 1974 Russian edition by Nauka Press, with 1977 supplementary material from the author.) McGraw-Hill, New York, 1979. pp. viii–939. Price $97.00.

REVIEWED BY J. R. RICE[4]

This is a translation of the 1974 Russian edition, with supplements provided by the author in 1977. Cherepanov is among the most original and imaginative contributors to the flowering of fracture mechanics theory in the late 1960s and 1970s. This book fairly reflects his remarkably diverse interests and insights.

Crack mechanics, mostly elastic, forms the central theme. There are strong sections on singular fields, plane elasticity solutions to crack problems, energy release-rate calculations, and self-similar elastodynamic solutions, and there is also a brief catalog of elastic crack solutions. In addition there is much contact, if not always developed very completely, with adjacent areas of physics and chemistry, ranging from principles of bonding to optically induced fracturing to ion transport in electrolytic solutions within crack spaces. Supplementary discussions and applications also have a wide scope. For example, there is a discussion of path invariant integrals not only as energy release-rate representations in fracture growth, but also as applied to dielectric phenomena and fluid dynamics. The fracture phenomena and mechanisms discussed include fatigue, environmentally influenced fracture, micromechanisms in fiber-strengthened composites, erosion, drilling, rockburst mechanisms, and much more. There is no shortage of speculation, and one cannot help but wish that the author had been a little more self-critical before jumping to facile explanations of plainly more subtle phenomena, for example, in the fatigue and corrosion cracking areas.

The flavor throughout the book is intensely personal, and one will be disappointed if it is approached as a compendium of all that is useful and permanent in the worldwide development of fracture mechanics. In the foreword to this English translation, Cherepanov warns his readers, and perhaps hopes thereby to deflect some critics, that his works have been ". . . criticized for paying too little attention to the points of view and works of others." He continues: "Unfortunately, I was unable to overcome this shortcoming in the present edition as well, as it represents primarily the results of my own work." The latter quote is certainly accurate, except perhaps that in many places the work could, with more accuracy, be called his synthesis in recapitulation and extension of the results of others. The referencing to others is often offhand, although in aggregate there are 475 references cited (of which 85 are to Cherepanov's papers). The selectivity leaves the book less strong than it could be on elastic-plastic frature phenomena, on unsteady crack dynamics, and on connections with fracture phenomena from the materials science viewpoint, e.g., as developed in the books by Knott and by Lawn and Wilshaw. Similarly, it is less successful than the book by Brock on structural applications. Yet this book is distinctly different in flavor from any of those three, and certainly stronger in basic mechanics.

Elementary Finite Element Method. By C. S. Desai. Prentice-Hall, Englewood Cliffs, N.J. pp. xiv–434. Price $22.95.

REVIEWED BY S. KELSEY[5]

The professed aim of this book is to provide a broad, but practical introduction to the finite element method, suitable for the undergraduate engineering student or other finite element novice. The method is presented, not as a development of matrix methods of structural analysis (a historical view) nor as a technique for the approximate solution of differential equations (a mathematician's view), but as a general and coherent approach to the analysis of physical behavior by discrete modeling.

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The essential scheme of the book is to develop understanding of the method and familiarity with its techniques by analyzing successively more complex and sophisticated problems. At the same time, the generality is emphasized by the range of different problems considered. Mathematical formality and rigor are kept to a minimum; in particular the calculus of variations is avoided, in keeping with the assumed mathematical background of the reader. Attention is directed almost exclusively to the generation and solution of the governing equations of the discrete systems. The reader is presumed to possess at least a basic understanding of the physical subjects treated.

While the author rightly emphasizes the value of hand calculation with small examples as a way of acquiring insight, he also emphasizes that it is only through the computer that the finite element method finds its real purpose and application. He is therefore at pains to provide in the book a detailed and well-documented computer program for one-dimensional problems. Information on other programs, applicable to many of the other topics covered in the book and available from the author, is also given.

The book really begins in Chapter 2, after a brief and rather mysterious philosophical disquisition on the idea of discretization, with an introduction of the basic concepts and a skeleton of theory. Not surprisingly, the first specific problem to be treated, in Chapter 3, is the axially loaded, elastic bar. The classic displacement analysis is derived both from the principle of minimum potential energy and from Galerkin's method. In addition, a mixed method, based on the Hellinger-Reissner principle, is presented. One-dimensional steady flow problems are next discussed and the close analogy with the elastic bar emphasized in Chapter 4. The flow problem also provides a vehicle for enlargement of the analysis into time-varying behavior in Chapter 5.

Chapter 6 contains the one-dimensional computer program, applicable to the foregoing models, and in Chapter 7 the bending behavior of beams serves as an example to introduce higher-order continuity conditions (slope as well as displacement) and, as a refinement, interpolation functions with continuity of curvature at nodes. The remaining one-dimensional problems treated are: mass transport (convection/diffusion equation), overland flow, and elastic stress-wave propagation in Chapters 8–10.

Two-dimensional problems are introduced in Chapter 11 via the St. Venant torsion problem. Four analyses are given. Besides the solutions in terms of warping and stress functions, there is a hybrid and a mixed method, all using simple triangular elements. Other two-dimensional field problems (potential flow, heat flow, and seepage) are treated in Chapter 12 to emphasize unity and generality, but the analysis uses simple (quadrilateral) isoparametric elements. Chapter 13 covers plane elasticity, using the displacement method.

In the final chapter (14), the scope of the finite element method and its applicability to heterogeneous systems is illustrated by a discussion of the modeling necessary for a building frame with slab floors and elastic foundations.

The range of technical subjects is very impressive and the versatility of the finite element method is clearly demonstrated. A student working through the book, with its constant reinforcement of ideas and tactics and its widening horizons, and making use of the computer programs available, must very quickly acquire familiarity and competence in basic finite element technology.

But there are some flaws, and these are mainly in basic, theoretical aspects. Thus, the idea of isoparametric elements is presented rather casually, and the "natural" or "intrinsic" coordinates, fundamental to the idea, are merely and misleadingly described as "local" coordinates, with no explanation. It is also difficult to see what the complementary energy method has to offer in the analysis of the axially loaded bar.

More serious, however, is the fundamental question of the variational basis of the finite element method. The author uses a mixture of approaches; sometimes a variational principle is invoked, sometimes the Galerkin method is applied, once the principle of virtual work. Discussion of these and their relationships can only be loose and qualitative without the help of variational calculus. Although the principle of minimum total potential energy, as a condition for equilibrium, should be familiar to an undergraduate from his or her physics training, the other principles used, like the Hellinger-Reissner, must be quite mysterious. And even if these are acceptable for defining element behavior, the question of natural boundary conditions is extremely obscure without the variational argument. A brief concise exposition of the essential variational approach would have added greatly to the strength of the book, by providing a clearer theoretical base to complement the development.

Continuum Mechanics. By A. J. M. Spencer. Longman Mathematical Texts, 1980. 183 Pages. Price $13.50.

REVIEWED BY R. L. FOSDICK[6]

The author has intended this book to be an introduction to the theory of continuum mechanics in a form that is suitable for undergraduate students. I think that his aim has been achieved and that the approach and scope of material covered is reasonable for the engineering undergraduate student at the junior or senior level. In 183 pages and 11 chapters it is not possible to stray too far from the beaten track and by design the author does not do so. The usual elements of the kinematics of motion and deformation, stress, and balance laws are to be found in a general and understandable setting which is not compromised by ad hoc linearity assumptions. There is one chapter that is devoted to linear constitutive relations for elasticity, classical viscous fluids, and viscoelasticity. In addition, there is one chapter that gives a brief, but instructive description of the constitutive theory for nonlinear hyperelasticity, and of the invariance restrictions that lead to the Reiner-Rivlin fluid. Simple materials with general history dependence are merely mentioned, and the basic elements of classical plasticity theory are discussed and formulated in four pages. There are two supporting chapters at the beginning of this book on matrix algebra, vectors, and cartesian tensors and one at the end of the book on cylindrical and spherical coordinates. The notion used throughout the book is a blend of direct or matrix (i.e., index-free) and the indicial for rectangular cartesian coordinates. There is no thermomechanics covered in this book. While there is a reasonable number of exercises on the mechanics topics with an appendix of answers, there are none that deal explicitly with vectors and tensors.

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