Finite Elements in Biomechanics. By R. H. Gallagher, B. R. Simon, P. C. Johnson, and J. F. Gross. Wiley, New York, 1982. pp. xiv–404. Price $48.50.

REVIEWED BY R. D. CROWNINSHIELD[3]

The First International Conference on Finite Elements in Biomechanics was held in Tucson, Ariz. February 18–20, 1980. This conference, which was sponsored by the United States National Science Foundation and the College of Engineering of the University of Arizona, contained about 60 presentations which covered a wide variety of finite element applications in biomechanics. The conference organizers (editors of this book) invited the authors of 18 of these presentations to prepare manuscripts for publication in this book.

The book starts with the introduction of a clinician's view and then a finite element specialist view of the method. G. T. Rab presents his views on the finite element method, special model problems with biologic materials, and problem of clinician-engineer collaboration. O. C. Zienkiewicz and D. W. Kelley then present the basic outline of the finite element process, its historical development, present trends, and its impact on the field of bioengineering.

The remainder of the book presents a diverse array of finite element applications in biomechanics. Two chapters address the mechanics of biologic fluid flow. Normal mechanics of capillary flow, arterial flow, blood cell deformation, and peristaltic flow are discussed. Special problems of pulsatile flow through a stenosis and through an aneurysm are also considered.

The application of the finite element method in soft tissue mechanics is demonstrated in an introductory chapter and a subsequent series of chapters dealing with the mechanics of the lungs and heart. Analyses of the role of interfacial forces in lung deformation, lung parenchyma, and the heart's left ventricle are discussed.

The remainder of the book, and by far the most indepth treatment of a subject, is devoted to the finite element method applied to solid mechanics, predominantly orthopaedic problems. After a survey chapter on the role of finite element models in orthopaedics, subsequent chapters address specific orthopaedic applications. An application of the finite method to external fracture fixation devices is followed by studies of stress-morphology relationships in trabecular bone, stress distributions in the femoral head, intervertebral disk function, the mechanics of artificial joint fixation, cement-bone failure, the function of femoral endoprostheses, and head and neck injury mechanisms.

This book assembles the highlights of what was a very interesting biomechanics conference. The presentations chosen for inclusion in this book survey well the diverse application of the finite element method to biomechanics problems and illustrate important problems unique to finite element modeling of biologic systems. The reader is introduced to problems associated with biologic variability, growth and maturation, nonlinear materials, anisotropic materials, incompressible materials, viscoelastic materials, and structural pathology. The book as a whole serves as an excellent introduction for the experienced finite element programmer to the applications and special problems of biologic system modeling. The individual chapters present new data, discussion, and reference useful to the reader with interest in one or more of the specific subject areas.

Optimality in Parametric Systems. By T. L. Vincent and W. J. Grantham. Wiley, New York, 1982. 243 Pages. Price $34.50.

REVIEWED BY W. STADLER[4]

If optimization methods are ever to become standard tools of analysis in industry, they must be introduced on a regular basis at an undergraduate level. The present book is very readable and could be used as an undergraduate text. With the exception of some supplements on differential calculus and cones in R^n, the needed mathematical background should include differential equations and linear algebra, a level usually attained by seniors in engineering.

Only about 30 pages of the book pertain to optimality in parametric systems, about half of the book concerns nonlinear programming, and the remainder is devoted to gametheoretic concepts. Throughout, it is generally assumed that the criterion functions and the constraint functions are differentiable as needed, resulting in theorems and proofs that are relatively easy to apply and follow, respectively.

With the exception of three examples and their various treatments, all of the examples are academic and there are no direct applications to mechanics. However, in mechanics, as well as in other areas, there is a need for a formal treatment of optimization problems involving the simultaneous "minimization" of several criteria. This requires some new notions of optimality. Although such concepts as Pareto optimality have been around in economics for nearly 100 years and game theory was conceived by Borel in 1921, they have only found their way into the engineering literature within the last 20 years. The authors provide a fairly detailed treatment of Pareto optimality as the optimality concept for the "vector maximum problem" and they treat Nash-equilibrium, min-max, and Stackelberg Leader-Follower solutions in a gametheoretic context. The authors, as well as others, usually introduce these concepts as possible resolutions between antagonistic "rational" players; however, they can also serve as optimality concepts for the vector maximum problem. Thus, min-max clearly is suited for worst case design, and the Nash-equilibrium concept could be used when one might wish to assure that one criterion maintain a lower bound when one of the design variables is changed with all others remaining fixed at the optimal design. Collectively, all of the games may be viewed as "games against nature" played by a single decision maker.

In summary, the book provides a needed transition from the treatment of these topics in monographs and in a research context to possible classroom use.

Theory of Dislocations (2nd ed.). By J. P. Hirth and J. Lothe. Wiley, New York, 1982. pp. xii–857. Price $72.95.

REVIEWED BY T. MURA[5]

This book is based on the lecture notes developed by the authors for courses on the theory of dislocations at Carnegie Institute of Technology, The Ohio State University, and Oslo University. The first edition of this book was published by McGraw-Hill, in 1968. The present major revision is made in the sections related to elastic theory of dislocations. Accordingly, the works of Willis, Barnett, and Asaro, among

[3] Associate Professor, Department of Orthopaedic Surgery, The University of Iowa Hospitals and Clinics, Biomechanics Laboratory, The University of Iowa, Iowa City, Iowa 52242.

[4] Associate Professor, Division of Engineering, San Francisco State University, San Francisco, Calif. 94132.

[5] Professor, Department of Civil Engineering, The Technological Institute, Northwestern University, Evanston, Ill. 60201.

others whose names did not appear in the first edition, are introduced in the second edition. These people advocated the importance of the line integral expressions for the elastic field of a dislocation loop. There is also added coverage of atomic calculations and new material on advanced anisotropic elastic theory and grain boundary dislocations. However, very little coverage is found in the area of continuous distributions of dislocations developed by K. Kondo, Bilby and Kröner, among others.

This book consists of four parts. Part 1 focuses on the fundamentals of dislocations (elastic theory of dislocations in isotropic continua); Part 2 on effects of crystal structure on dislocations (the Peiels-Nabarro dislocation model, partial dislocations, kinks, and anisotropy of crystals); Part 3 on dislocation-point defect interactions (thermal kinks and jogs, pinning and drag of Cottrell, Snoek, and Suzuki's atmospheres); and Part 4 focuses on groups of dislocations (dislocation models of grain boundaries, dislocation sources, pileups and twinning).

Compared with Nabarro's book (*Theory of Crystal Dislocations*, Oxford 1967), this book provides sufficient detail for the book to be effectively used as an undergraduate text, as well as extended treatments of specific problems to stimulate advanced graduate students and scientists.

Micromechanics of Defects in Solids. By T. Mura. Martinus Nijhoff, The Hague, 1982. pp. x–494. Price $98.00.

REVIEWED BY D. M. BARNETT[6]

Much of what might be termed advances in the mathematical treatment of defects (inclusions, inhomogeneities, dislocations, and cracks) in solids tends to be scattered throughout the journal literature; as a result, the researcher intent on entering this field faces the rather formidable task of deciding on the best way in which to begin learning about the theory of defects. Prior to the appearance of Professor Mura's monograph, *the* single outstanding text available to such a researcher was *Theory of Dislocations* by J. P. Hirth and J. Lothe, now available in its second edition. The Hirth and Lothe book is, in my opinion, a beautiful exposition of great lasting value. Nonetheless, I have long had the feeling that it is more easily digested by one trained in solid state physics or materials science than by one whose primary bent is solid mechanics; in addition, Hirth and Lothe devote very little space to J. D. Eshelby's famous "transformation strain" problem, whose solution and attendent results should be in the "bag of tricks" carried by every Ph.D. materials scientist. Professor Mura's book more than adequately fills both gaps. Over one-third of the book is devoted to the treatment of inclusions and inhomogeneities in isotropic and anisotropic linear elastic solids, and the development of the subject matter should please readers familiar with either solid mechanics or applied mathematics.

The first chapter introduces the notion of eigenstrains and emphasizes in a self-contained way the use of elastic Green's functions to represent the solution to eigenstrain problems. The next three chapters provide a most complete survey of inclusion and inhomogeneity problems and contain a wealth of formulas which should prove most useful to those requiring solutions to this class of problems. Cracks and dislocations in elastic solids receive a reasonably complete treatment in chapters 5 and 6. The final chapter emphasizes the use of techniques and solutions introduced previously to model phenomena of importance to mechanical metallurgists, including work-hardening of dispersion strengthened alloys, stress relaxation via diffusion, and polycrystal plasticity.

In summary, Professor Mura's book may be heartily recommended to those interested in either applying or learning to apply the methods of continuum mechanics to treat defects in the solid state. This monograph could serve as the perfect text for a second-level graduate course with the same title as that of the book.

[6] Professor, Department of Materials Science, Stanford University, Stanford, Calif., 94305.

Advanced Engineering Analysis. By J. N. Reddy and M. L. Rasmussen. Wiley, New York, 1982. pp. xiv–488. Price $39.95.

REVIEWED BY L. WHEELER[7]

The aim of this book is to present a unified treatment of three topics, namely vector and tensor analysis, functional analysis, and the calculus of variations for an audience of students in engineering and applied science. It is based on class notes used by the authors in teaching seniors and first-year graduate students, and for the most part, its level and style reflect these origins. Exercises are included. They are well chosen and suitably placed.

The subject of functional analysis is important to much of modern science and I believe that a useful purpose is served by bringing it to a wider audience. An initiate to this field faces a rather bland literature which might seem merely to proliferate abstract function spaces. Here the authors have something to offer. They have put together a concise introductory treatment where a student can pick up the basic concepts.

The remaining two parts of the book do not seem to measure up to the part on functional analysis. While the treatment of the calculus of variations benefits slightly from the emphasis placed on methods of approximation and computation, I am disappointed to see it so weakly linked to the functional analysis that precedes it in the book.

A major goal of the vector and tensor part is evidently to ease the student into functional analysis. While it might also be intended to furnish mathematical preliminaries for such subjects as modern continuum mechanics, this purpose is hindered by the notation, level, and style of the presentation. In particular, I fail to see why portions of it are so elementary.

I recommend this book as a course book to those who teach functional analysis and variational methods to students interested in applications. Further, it is written so that students in need of outside reading should find it helpful. It would deserve serious attention as a textbook, but I doubt whether many institutions offer a course to which it is closely suited.

Spacecraft Dynamics. By T. R. Kane, P. W. Likins, and D. A. Levinson. McGraw-Hill, New York, 1982. 436 Pages. Price $49.50.

REVIEWED BY R. L. HUSTON[8]

This book is a welcome addition to the literature on spacecraft dynamics and on dynamics itself. It is basically a textbook, but it will undoubtedly become a reference for engineers and designers as well. Although the book has only

[7] Professor, Department of Mechanical Engineering, University of Houston, Houston, Texas 77004.

[8] Professor, Department of Mechanical and Industrial Engineering, University of Cincinnati, Cincinnati, Ohio 45221.

Part I. Isotropic Continua: 1. Introductory material; 2. Elasticity; 3. Theory of straight dislocations; 4. Theory of curved dislocations; 5. Applications to dislocation interactions; 6. Applications to self energies; 7. Dislocations at high velocities; Part II. Effects of Crystal Structure: 8. The influence of lattice periodicity; 9. Slip systems of perfect dislocations; 10. Partial dislocations in FCC metals; 11. Partial dislocations in other structures; 12. Dislocations in ionic crystals; 13. In materials science, a dislocation or Taylor's dislocation is a crystallographic defect or irregularity within a crystal structure. The presence of dislocations strongly influences many of the properties of materials. The theory describing the elastic fields of the defects was originally developed by Vito Volterra in 1907. The term 'dislocation' referring to a defect on the atomic scale was coined by G. I. Taylor in 1934. Some types of dislocations can be visualized as being caused by the termination