Brownian motion, and Kramer's rate formula are included in the rate theory chapter. One suggestion (for a possible second edition) would be the inclusion of more applications that are carried through to quantitative conclusions, such as specific atomic based-computations of elastic behavior of crystals, including finite, nonlinear deformation (some examples can be found in *Mechanics of Solids*, edited by H. G. Hopkins and M. J. Sewell, Pergamon Press, 1982).

The second part begins with a clear, concise, self-contained chapter on the basic concepts of quantum mechanics, intended for mathematically sophisticated readers without prior quantum mechanics background. In the subsequent chapters, quantum mechanical concepts are employed in discussions of interatomic interactions, and quantum statistical mechanics is formulated and applied to situations where quantum effects become important, including specific heat and elastic moduli at low temperature and quantum tunneling and its influence on rate processes. The variety of topics in the quantum mechanics sections is less extensive than in the sections on classical (i.e., nonquantum) phenomena, although a good selection of quantum-based applications is included (some of these, e.g., elastic moduli based on the Hellmann-Feynman theorem, evidently have not yet appeared in other texts). One omission that is notable (because of its usefulness in computing atomic bonding and elastic constants in a wide variety of crystals) in the pseudopotential method.

In summary, Professor Weiner has written a splendid book which should encourage workers and students in solid mechanics to focus their attention on the atomic bases of material deformation, as well as to provide materials scientists and solid state physicists with an appreciation for the value of combining solid mechanics and atomistic approaches in the study of mechanical properties.

Stress Analysis for Creep. By J. T. Boyle and J. Spence. Butterworths, Woburn, Mass., 1982. 283 Pages. Price $59.95.

REVIEWED BY Z. P. BAŽANT[8]

This book by well-known experts is a valuable addition to the literature on creep of metals at high temperatures. As the title suggests, the book is more concerned with engineering mechanics than with the problems of constitutive relation. The first two chapters explain the nature of creep, the consequences of this phenomenon for the behavior of structures, and the basic types of stress-strain relations for creep. The next two chapters present a set of typical simple examples of one-dimensional and three-dimensional structural response to steady, transient, and cyclic creep. Chapter five, dealing with steady-state creep analysis, concentrates on the use of energy principles but also explains iterative numerical methods where particular attention is paid to linearization by differentiation (quasilinearization). Chapter six discusses how the stress-strain law can be identified on the basis of reference data consisting only of uniaxial test results. In the next chapter, the authors focus on stress analysis for transient creep; first the mathematical statement of the problem is given and then numerical methods are discussed in detail, including both the explicit and implicit integrations in time, along with the questions of numerical stability of various schemes, error estimates and handling of stiff equations. This then leads to an exposition of approximate methods for transient creep problems in chapter eight, in which various bounding techniques and convergence questions are lucidly analyzed. Discussion of simplifications such as the exploitation of other known solutions based on comparison theorems are particularly useful. The subsequent two chapters examine two possible types of failure due to creep, i.e., creep rupture and creep buckling. The existing mathematical models to describe material damage are presented and a relatively new approach known as continuum damage mechanics is introduced. Creep buckling is illustrated by typical examples, and this discussion is then extended to creep in presence of large deformations. The final, eleventh chapter addresses the principal concern – the design for creep, including the current design methodologies and identification of the material parameters from the given creep data and their extrapolation.

The book represents an outstanding contribution to the literature on the subject, and only very few critical points can be raised. References in the text are in most chapters somewhat limited and selective bibliographies are substituted for reference lists. The discussion of continuous damage mechanics would have benefited by warning of possible material instability, such as strain-localization, and of the lack of the size effect in failure, which are inherent to this approach. The drawings of the inclined views of three-dimensional situations in Figs. 4.7 and 7.12 are self-contradictory; they ignore the principles of descriptive geometry, as abstract painters do, and are disturbing to the trained eye of an engineer. From the viewpoint of present practice the finite element approach could be treated in more detail, and more attention could be given to constitutive laws that often cause a greater error than the method of stress analysis. It is also curious that the step-by-step time integration is not treated systematically as a sequence of incremental elastic problems with initial strains, as is commonplace in the creep analysis of concrete structures. In fact, the book as a whole reflects the fact that the creep theories of metals and of concrete are evolving in isolation, although one of these could not doubt benefit from the other despite fundamental differences in the constitutive law (cf. Z. P. Bažant and F. H. Wittmann, editors, *Creep and Shrinkage in Concrete Structures*, Wiley, London, 1983).

These points are, however, minor in view of the many strong aspects, among which the up-to-date and perspicacious treatment of approximate methods and bounding technique may be emphasized. In contrast to previous books on the subject, the examples are not elementary but deal with real life situations in which the difficulties of stress analysis must be confronted. The authors work out their examples in considerable detail and make frequent use of the computer, in the spirit of their motto: "To appreciate creep analysis, the reader must compute. If he does not, his understanding of the subject will be poorer." On the whole, the book is highly recommended to students of the subject as well as researchers and practicing engineers.

Fundamental Concepts in the Numerical Solution of Differential Equations. By Joseph Botha and George Pinder. Wiley, New York, 1983. 202 Pages. Price $24.95.

REVIEWED BY A. T. PATERA[9]

This book presents the finite-difference, Galerkin-based finite-element, and collocation-based finite element techniques for numerical solution of elliptic, parabolic, and hyperbolic partial differential equations. The book contains seven chapters. The first chapter reviews notation and general

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properties of ordinary and partial differential equations. Chapter 2 briefly summarizes interpolation theory, and introduces the discretizations (finite-difference, Galerkin, collocation) to be examined in the text. A boundary value problem is solved to compare the various approaches. Chapter 3 extends the finite element concept to two dimensions, discussing element type, isoparametric formulation, and numerical quadrature. Chapters 4–6 present numerical techniques for solution of elliptic, parabolic, and hyperbolic partial differential equations, and Chapter 7 deals with nonlinear and singular equations.

On the positive side, the book takes the refreshing and uncommon approach of presenting several different methodologies side-by-side so as to highlight their similarities as well as their differences and relative merits. The finite element methodology (Galerkin-based, collocation-based, and boundary formulations) is very nicely treated; topics such as direct stiffness, isoparametric transformations, and choice of basis are handled succinctly yet in sufficient detail to allow practical implementation. Model problems are effectively used, and the balance between theory and practice is reasonable. The (six–seven) problems associated with each chapter are generally good, allowing reinforcement and extension of the material covered in the text with little (perhaps too little) programming complexity.

On the negative side, a number of essential topics are given inadequate coverage in the book. In particular, solution of linear systems is given very cursory treatment, with certain key ideas never mentioned. Conditioning problems are analyzed in terms of the concepts of consistency, stability, and convergence usually reserved for evolution problems, and the resulting conclusions are imprecise and somewhat confusing. High-order methods (e.g., spectral or compact), refinement techniques (e.g., Richardson extrapolation), effect of inadequate resolution (in particular on singularly perturbed problems), behavioral errors (numerical diffusion and dispersion), and variational formulations are, in this reviewer's opinion, given insufficient attention. Lastly, the title of the book is slightly misleading, as the book is primarily concerned with *partial* differential equations; treatment of *ordinary* differential equation initial value problems is not discussed.

The authors could have included the topics just mentioned by either increasing the length of the book (it is relatively short as is), or by eliminating some of the detailed collocation calculations (collocation receives more attention than its current usage warrants). However, for use as a text in a *general* course, these omissions are probably less serious than those inherent in the many books that deal exclusively with one methodology (e.g., finite-difference, finite element). Inasmuch, this book, appropriately supplemented, is a welcome pedagogical alternative to existing texts on numerical solution of partial differential equations.