finite element modeling of structural dynamic systems coupled with the tremendous advances in computer technology. Much of this activity has been centered on the development and refinement of computational methods capable of dealing with structural systems having a large number of degrees of freedom. Professor Meirovitch's excellent book on this subject represents a timely and valuable treatment of this important field, which is a natural sequel to his previous book (*Analytical Methods in Vibrations*, Macmillan, 1967). The book is self-contained and presents a large amount of material on the subject in a complete and very readable manner.

The book has a very logical structure. The first chapter presents a collection of concepts from linear algebra which is essential to the understanding of the subject matter treated subsequently in the book. Chapter 2 deals with the free vibration of discrete systems, presenting the necessary background and tools for formulating free vibration problems for undamped, damped, and gyroscopic systems. The material in this chapter is, by necessity, condensed and the uninitiated reader will find it useful to consult Professor Meirovitch's previous book for the additional clarification of some fundamental concepts. Chapter 3 presents a general overview of the eigenvalue problem for a variety of structural dynamic systems without delving into numerical details. Thus, it essentially contains additional material from linear algebra required for the complete and proper understanding of eigenanalysis.

Chapter 4 is devoted to the qualitative behavior of the eigensolution based on Rayleigh's principle. Various additional important topics such as the minimax theorem, the inclusion principle, Gerschgorin's theorem, and first-order perturbations of the eigenvalue problem are discussed in a lucid manner.

Chapter 5 contains a (72 pages long) detailed discussion of the computational methods used in eigensolution. Starting from the power and Jacobi's methods, more advanced methods such as Givens, Housholder, Sturm, and *QR* methods are discussed in detail.

Chapter 6 is devoted to the response calculation of linear discrete systems both damped and undamped. Direct numerical integration methods in the conventional sense, are not considered in this chapter.

Chapter 7 and 8 are closely related. Chapter 7 presents a few exact solutions to simple, continuous, free vibration problems while Chapter 8 considers approximations to the same problem by global discretization methods such as the Rayleigh-Ritz and weighted residual methods. Chapter 9 continues the treatment of spatial discretization, except that it is now accomplished on a local level, by using finite elements. This relatively detailed chapter (50 pages) presents the finite element method in a relatively complete manner.

The introduction of the finite element method yields structural dynamic systems having a large number of degrees of freedom; the treatment of such systems is the objective of the last two chapters of the book. Chapter 10 considers reduction of system size by static condensation, mass condensation, or the calculation of the lowest modes only by direct simultaneous iteration or subspace iteration. Chapter 11 concludes this topic by presenting a number of substructuring methods such as component mode synthesis, branch-mode analysis, component-mode substitution, and substructure synthesis.

The book also contains a considerable number of small examples illustrating the basic aspects of the various methods presented. These examples however are restricted to systems having four degrees of freedom or less. It would have been nice to see in a computational book, such as this one, some more complicated examples including computational treatments utilizing actual computer programs that contain algorithmic implementations. The book is remarkably complete, considering the wide scope of the subject matter; however, direct numerical integration of the equations of motion also should have been included, since it deserves at least one whole chapter in a book having a computational flavor.

The book can serve as an excellent textbook for a graduate level course on this topic. It is also highly recommended to engineer analysts and researchers working in the field of structural dynamics.

Topics in Finite Elasticity. By M. E. Gurtin. Society for Industrial and Applied Mathematics, Philadelphia, Pa., 1980, Price $9.50.

REVIEWED BY JAMES K. KNOWLES[4]

This little-book—it is only 58 pages long—is the published version of a series of lectures given by the author at the University of Tennesee and sponsored by the National Science Foundation under the auspices of the Conference Board of the Mathematical Sciences. There are 15 short, tightly written chapters, of which the first 10, together with Chapter 13, might be regarded as setting out the basic ingredients of the theory of finite *equilibrium* deformations of elastic solids. The remaining four chapters deal with loosely related special topics which represent some of the currently active areas in finite elastostatics: the variational formulation of the basic boundary value problem (Chapter 11), stability and uniqueness (Chapter 12), the multiplicity of possible deformations of an incompressible cube under uniform all-around tensile loading (Chapter 14), and finite antiplane shear (Chapter 15).

The presentation of the fundamental theory of finite elasticity as given here is clear, direct and well organized, but necessarily so concise that the potential reader who is curious about—but unfamiliar with—continuum mechanics might find the going a bit hard. (Chapter 13 is only one page long!) Some results are proved, but of course others are not; references to appropriate sources are given. The dynamical theory is not treated, nor is the connection between finite elasticity and the classical linear theory of infinitesimal deformations of an elastic solid.

Chapter 11 on the variational formulation of the "mixed" boundary value problem of the theory deals with weak solutions and establishes the principle of stationary potential energy for them. In this connection, there is some discussion of the role played by such possible restrictions on the strain energy function as quasi-convexity or the Legendre-Hadamard condition.

The discussion of stability and uniqueness in Chapter 12 is devoted primarily to recent joint work of Gurtin and S. J. Spector. It focuses on the relation between certain static (or quasi-static) notions of stability on the one hand and local uniqueness of weak solutions on the other.

The lack of uniqueness that may arise when finite deformations are taken into account is illustrated in Chapter 14 by an explicit analysis of the homogeneous deformations possible in an incompressible cube of Neo-Hookean material subject to uniformly distributed equal tensile normal forces on all of its deformed faces.

Finally, the subject of finite antiplane shear of a cylindrical incompressible solid appears in Chapter 15, supplying as it usually does the simplest setting in which to explore some aspect of the general theory. In this case, the question studied

[4] Division of Engineering and Applied Science 104-44, California Institute of Technology, Pasadena, Calif. 91125

concerns the consequences for the equilibrium problem of nonconvexity of the potential energy functional. The chapter is based on recent joint work of R. Temam and the author.

A list of some 49 references is included. This little monograph conveys nicely some of the features of finite elasticity which make it an active flourishing field today. I found it enjoyable reading.

The Dynamics of Arches. By Josef Henrych. Elsevier, Amsterdam and New York. 1981. Pages 00–463. Price $85.00.

REVIEWED BY G. J. SIMITSES[5]

This book primarily deals with the subject of linear small oscillations (free and forced) of mainly planar arches and frames. The geometry of the configurations is very general and the analysis includes the effects of nonuniformity in the cross section, rotatory inertia, tangential inertia, transverse shear, and extensionality (compressibility) of the neutral axis. Solution procedures are presented with great detail and sophistication for specialized geometries, such as the circular arch and straight bars. In all of these solutions, the various effects previously mentioned for both free and forced vibrations can be fully assessed from the derived formulas. In the case of forced vibrations, both the method of resolution according to normal modes of vibration and the method of decomposition into forced motion and free vibration are presented. The question of accuracy of the two methods is continuously addressed, and a comparison between the two methods is given. Moreover, these two methods are applied in the analysis of frames with straight and curved bars, which are excited either by (dynamic) forces or kinematically. In addition, the vibration analysis of some space frames is presented. The space frame may also be excited kinematically. Finally, some numerical (computer-obtained) results are presented for a few special configurations (simple geometries). These results were contributed by Dr. J. Pavlik and Mr. F. Cermak.

This book is recommended to the practicing engineer who is concerned with vibration analysis of arches, beams, and frames. The derived formulas and equations can be programmed, and extensive parametric studies can be performed to assess the effect of various parameters on the vibration response characteristics of the analyzed systems. It is also recommended as a reference text to the student of structural dynamics. Unfortunately because of the course structure in American technical universities and because of the highly specialized topics covered in the book, it cannot possibly be adopted as a text for a course in structural dynamics (small oscillations, theory of vibrations, etc.) regardless of the field of study (aerospace, civil, mechanical, or mechanics).

[5]Professor of Engineering Science and Mechanics, George Institute of Technology, Atlanta Georgia, 30332.