One of the virtues of a book like this is that the different parts of the subject can be treated with a uniform vocabulary and approach. The basic definitions of stress, strain, strain rate, and viscoelasticity are given in Chapter 2. While this information may not be new to graduate students in applied mechanics, it is useful to have it written down and connected to biomechanics in an orderly way. Chapters 3, 4, and 5 deal with flow properties of blood, red blood cells, the deformability, and the rheology of blood in the microvessels. These chapters will give a fresh survey of the complicated field of blood cell properties and blood rheology. These chapters are a good example of Professor Fung's ability to set down the main facts in clear form. There is a good bit of advanced analysis in the literature which is not given here in any detail. Examples would be the solution of Stokes equations for various particles in capillary flow and the many different models that have been studies for wave propagation in blood flow. Presumably these will be covered in two later volumes which Professor Fung has promised in the introduction to the present book.

Bioviscoelastic fluids including protoplasm, mucous, saliva, cervical mucous, semen, and synovial fluid are treated in Chapter 6. Here again the main facts and adequate references are well summarized.

The next five chapters deal with soft tissues and are largely drawn from the research work of Professor Fung, his associates, and students. Chapter 7, on bioviscoelastic solids, is an especially long and important chapter. It contains informative descriptions of elastin collagen. It also contains general discussion of thermodynamics of elastic deformation, generalized viscoelastic relations, the complementary energy function, and inversion of stress-strain relationships. The idea of pseudoelasticity using a model of one elastic material in loading and another elastic material in unloading is developed. The reduced relaxation function is introduced and illustrated in this chapter by application to experimental data on rabbit mesentary. The notion of the reduced relaxation function is used repeatedly in the remainder of the book. It allows a reduction of a good deal of data on soft tissues which is highly nonlinear in its elastic behavior but linear in its viscoelastic response.

Chapter 8 deals with the mechanical properties of blood vessels. The arterial wall is another example in which the reduced relaxation function idea is useful. This chapter includes discussions of capillary blood vessels and the sheet flow in the alveolar walls of the lung which was developed by Professor Fung and his associates. The chapter closes with a discussion of the properties of the veins but does not go into the many interesting phenomena that occur when veins collapse. These will no doubt appear in later volumes.

The next three chapters, Chapters 9, 10, and 11 on skeletal muscle, heart muscle, and smooth muscles are like a minibook within the book, and surely represent a topic of great importance and particular interest. Here Professor Fung has tackled the difficult subject of describing the active contraction of muscles as well as their passive behavior when relaxed. Although some fault is found with Hill's classical three-element model, it is clear that the discussion is still an imcomplete one. These chapters show that the variety and complexity of muscles is very great and a complete description must take into account a variety of detailed anatomical features and biochemical influences. The chapter on smooth muscle is most interesting, probably because the spontaneous cyclic contraction has an air of independence and mystery about it.

The book closes with Chapter 12 on bone and cartilege. This is a comparatively short chapter but gives the main known facts about the structure, variability, and properites of bones. Although the strains are small because bones are stiff, the discussion of material properties is no less difficult than for soft tissues due to the complex heterogenity and anisotropy of bones. The questions of growth and resorption in bone are dealt with only briefly but at least more rationally than much of the literature. The last few sections on cartilege and lubrication of articular surfaces give the main effects leading to the very small coefficients of friction between typical articular cartilege surfaces. Synovial fluid was discussed previously in Chapter 6.

There are omissions which one could complain about except that the subject is so large that something must be omitted. Workers interested in the cornea or other parts of the eye or the ear will probably feel left out. One area which has received no mention is that of the brain and neutral system. This reviewer is convinced that neural mechanics is underdeveloped, say, compared to vascular mechanics and that the return on such development would be very much worthwhile. A discussion of teeth, the stiffness of their sockets, and the properties of the various components might also be of interest. Finally it should be pointed out that besides some data on frogs, almost all of properties discussed are of mammalian tissues. Fish, plants, seashells, and other interesting forms such as coral are not mentioned. Of course the inclusion of all of these topics might require another volume but people in agriculture and marine biology would probably like to see similar books for their fields.

This is a book that will surely be a standard text for some time. We will all be looking forward to seeing the two additional volumes which are promised in the Introduction. The next volume will be on the mechanics of circulation and respiration. A third volume on advanced biomechanics will include recent developments where advanced methods in contiuum mechanics and analysis have to be used. As Professor Fung has so aptly said in his preface, "Biomechanics at the level or current research cannot be bound by elementary mathematics." We will look forward to the forthcoming volumes to be as interesting and useful as the present first fine volume.

A Modern Course in Aeroelasticity. Edited by E. H. Dowell. By E. H. Dowell, H. C. Curtiss, Jr., R. H. Scanlan, and F. Sisto. Sijthoff and Noordhoff, Alpen aan den Rijn, The Netherlands, 1978. pp. v-464, Price $90.00.

REVIEWED BY R. M. BENNETT[3]

Aeroelasticity is an important hybrid field that treats the stability and response of flexible structures under fluid dynamic loading and includes the phenomena of flutter, divergence, buffeting, and gust response. The applications primarily involve aerospace vehicles but also include areas such as the civil engineering problems of the response of bridges, smoke stacks, and so forth, to wind loading. There are several well-known textbooks (references [1–4]) but they are several decades old and do not reflect recent developments and emphases. The two more recent books [5–6] are not available in English. This book is an effort to satisfy the need for a modern textbook.

Chapters 1–4 are by Prof. Dowell. After a brief introduction (Chapter 1, 2 pages), static aeroelasticity (Chapter 2, 44 pages) is considered. Deflection and divergence of a typical two-dimensional wing section are treated, followed by beam and surface representations of finite wings and by a brief section on the flow through flexible pipes. Chapter 3

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(112 pages) presents dynamic aeroelasticity starting with the basic principles and equations for the typical wing section, and progressing to the analysis of complex structures and pipe flows. Chapter 4 (108 pages) is on nonsteady aerodynamics of lifting and nonlifting surfaces. It starts with the basic fluid equations and takes the reader through subsonic and supersonic flows over airfoils and wings. Consistent with the current state of the art, unsteady transonic flows are described by approximate methods.

Chapter 5 (14 pages), by Professor Sisto, discusses stall flutter. It gives an overview of the phenomena including a nonlinear mechanics description. In Chapter 6 (46 pages), Professor Scanlan gives a valuable and unique exposition of the aeroelastic problems of civil engineering structures such as divergence, vortex shedding, and flutter of bridges, and galloping of cables. Chapter 7 (56 pages) by Prof.Curtiss is on the aeroelastic problems of rotorcraft and gives a brief description of blade dynamics, stall flutter, and blade motion/body coupling. In Chapter 8 (28 pages), Prof. Sisto describes aeroelastic problems in turbomachines highlighting the special problems encountered in axial flow compressors.

Appendix I (8 pages) by Prof. Dowell, is a primer for structural response to random pressure fluctuations and gives a good resume of an application of modern spectral analysis techniques. Appendix II (38 pages, Prof. Dowell) gives some example problems that are pertinent to Chapters 2–4 and their solutions.

This book gives a good exposition of basic principles and a good overview of the diverse field of aeroelasticity from a modern point of view. As the title indicates, it is primarily directed as a textbook rather than to the practitioner. It supplements reference [1] rather than replacing it, however, as the range of topics considered are somewhat different. Further emphasis might have also been given to testing techniques and experimental results. The book is recommended and Profs. Dowell, Sisto, Scanlan, and Curtiss are to be commended for this addition to the literature.

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The Calculus of Variations and Optimal Control. By George Leitmann. Plenum Press, New York, 1981, 311 pages. Price $35.00.

REVIEWED BY DANIEL TABAK[4]

A large variety of books covering the topics of calculus of variations and optimal control exists. Thus, a reader may naturally ask: what is so special about this book that would justify its addition to the practically oversaturated market? Once the book is read, the answer to this question becomes simple: it is not the contents of the book, but the way the book is written that makes it so special and outstanding. Before elucidating on this point, let us first look at the contents.

The book covers the basic theory of the calculus of variations and optimal control. It is accordingly divided into two parts; Part I, Calculus of Variations (Chapters 1–8) and Part II, Optimal Control (Chapters 9–17). Part I includes the topics of necessary conditions for an extremum, integration of the Euler-Lagrange equation, the inverse problem, the Weierstrass and Jacobi necessary conditions, and the corner conditions. Part II includes the topics of optimality principle, optimal trajectories, Maximum Principle, special cases of optimal control problems, sufficient conditions, feedback control, and optimization with vector-valued cost. The last topic makes the book just about unique contents-wise; very few books touch on it. Practically all chapters contain illustrative examples and exercises for students. A list of references, an extensive bibliography and and index are given at the end of the book.

The book contains a rigorous mathematical presentation of the basic theoretical results. At the same time it is very clearly written and easy to learn from and to teach with. (In fact, it has already been successfully used by this reviewer as a self-paced text for graduate students.) Its numerous solved examples and clear figures make it even more attractive to the reader. It contains some specific economic and aerospace application examples of optimal control implementation.

It is this particular combination of mathematical rigor with an excellent tutorial lucidity that makes the book so unique and its use so widely recommendable. The book can serve as a excellent primary text in optimal control for graduate students. Since it contains examples from many diverse areas, it is not restricted to any particular discipline. It can be used by students of engineering, mathematics, operations research, economics, and other related areas.

Mechanics of Wave Forces on Offshore Structures. By T. Sarpkaya and M. Isaacson. Van Nostrand Reinhold, New York, 1981. pp. xiv-651. Price $37.50.

REVIEWED BY J. V. WEHAUSEN[5]

The authors' purpose, as stated in the preface, is to bring into one place the extensive and widely dispersed literature on wave forces on offshore structures. They speak of the work as a text and suggest that it could be used for a graduate course in ocean engineering. Have they succeeded? In my opinion they have, provided that one takes account of their approach to the problem of expounding a large amount of material.

The book is divided into nine chapters, a short introduction discussing the nature of the engineering problems encountered in analyzing ocean structures, another short chapter reviewing the fundamental equations for an incompressible Newtonian fluid, and then seven chapters with the following titles: "Flow Separation and Time-Dependent Flows," "Wave Theories," "Wave Forces on Small Bodies," "Wave Forces on Large Bodies," "Random Waves and Wave Forces," "Dynamic Response of Framed Structures and Vortex-Induced Oscillations," and "Models and Prototypes."

Chapters may be read reasonably independently of one another, but may be considered self-contained only if one comes to the book with "a good background in mathematics and fluid mechanics," a prerequisite stated in the preface. With such a background, any serious reader will find this an invaluable guide to the current literature. Each chapter is followed by an extensive bibliography in which, with few exceptions, complete author, title, and source data are given, thus making it easy for the reader to locate referenced papers. Although developments within the chapters are not sufficiently detailed to allow one to avoid going back to the

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