matics, especially analysis, topology, and dynamical systems. On the other hand, mathematics, after a long period of comparative and almost essential isolation during which it honed its tools to fine sharpness, is now under considerable pressure to demonstrate its practical usefulness and applicability. The time is ripe for interaction. Of course, the subjects have not always been divided and this is perhaps most evident in the relation of mathematics to mechanics. Names such as Bernouilli, Euler, and Cauchy are equally famous in both fields.

The declared aim of a conference held in 1975 at the University of Lecce in Italy was to assist in the revival of this traditional collaboration. People eminent in mathematics or theoretical mechanics gathered together and the lectures delivered are now admirably reproduced in this volume. The papers cover a wide cross section of topics centered mainly on functional analysis, differential equations, invariant forms, and advanced theories of mechanics. The flavor is best conveyed by listing the individual contributions. These are: Global thermodynamics, exterior Banach forms and Gateaux differential equations (D.G.B. Edelen); Singular perturbations (A. Erdélyi); Abstract and numerical aspects of the problem concerning the computation of eigenfrequencies of continuous systems (G. Fichera and M. A. Sneider); Some geometric properties of a system of first-order nonlinear partial differential equations (W. Fiszdon and Z. Peradzyński); Duality and convection in continuum mechanics (P. Germain); Qualche problema di elettrogmagnetismo (D. Graffi); Aspetti variazionali nella meccanica dei continui con deformazioni finite (G. Grioli); Nonlinear dissipative and dispersive wave propagation (A. Jeffrey); Wave propagation (F. John); Nonexistence of global solutions to nonlinear Cauchy problems arising in mechanics (R. J. Knops and B. Straughan); On the complementary energy theorem in nonlinear elasticity theory (W. T. Koiter); Solutions asymptotiques de l'equation di Dirac (J. Leray); Variétés symplectiques et variétés canoniques (A. Lichnerowicz); Coupled fields in elasticity (W. Nowacki); The analyticity of solutions of partial differential equations and its application (O. A. Oleinik); The application of the theory of invariants to the study of constitutive equations (R. S. Rivlin); Large deformations of crystals, homotopy, and defects (D. Rogula); Mathematical foundations of the theory of dimensions, analogies, and similarity (J. Rychlewski); On some invariant-theoretic problems of continuum mechanics (G. F. Smith); On certain mathematical problems occurring in the analysis of fracture phenomena (M. Sokolowski); Sulla elastostatica degli archi (F. G. Tricomi); Some mathematical problems in the nonlinear theory of elastic membranes, plates, and shells (H. J. Weinitschke); Foundations of neo-classical thermodynamics: metrization of direct thermodynamic processes (K. Wilmański); Pseudocontinuum analysis of discrete structures (H. Zorski).

All the contributors have successfully provided comprehensive and comprehensible surveys of their respective fields and this collection of papers will be found valuable for this feature alone. But the engineer and mathematician who are concerned with a broader view will find in this volume much more. They will discover how mathematics has brought clarification and precision to the engineering theories, while at the same time these theories supply at the very least a soundly based intuition for mathematics. Furthermore, the style and content of each paper should appeal to both groups, since there is neither too much nor too little of either abstruse mathematical theory or involved physical argument.

The organizers of the original conference and the editor of the volume are to be congratulated on their fine efforts. There is every indication that this laudable example is being repeated and resulting in healthy collaboration.

The volume is expertly produced with excellent topography and layout. The editorial work is of equally high standard.

Viskoelastizität und Plastizität. Thermomechanisch Konsistente Materialgleichungen (Viscoelasticity and Plasticity. Thermomechanically Consistent Constitutive Equations). By Peter Haupt. Springer-Verlag, Postfach, Heidelberger Platz 3, D-1000 Berlin 33, Germany. 1977. Pages x-208. Price $14.10.

REVIEWED BY ERHARD KREMPL[5]

The book treats viscoelasticity and plasticity in the framework of modern nonlinear continuum mechanics. As the subtitle suggests the emphasis is on defining thermomechanical constitutive equations consistent with general principles of continuum mechanics. Initial chapters deal with general principles of mechanics and thermomechanics and the definition of thermodynamically and thermorheologically simple materials. Using a special fading memory hypothesis an asympototic bilinear approximation of the free energy functional is given from which integral expressions for the stress, the entropy and the dissipation are derived for finite nonlinear and linear viscoelastic and thermorheologically simple materials.

Viscoelasticity is defined by invoking a fading memory hypothesis. Plasticity phenomena are said to be associated with perfect memory and are represented by defining a nondecreasing, rate-independent scalar parameter of process measuring the arc length in the six-dimensional space of the Cauchy-Green deformation tensor (endochronic time). This new parameter of process replaces real time in a functional representation. The last two chapters explore the properties of the endochronic theory under isothermal, uniaxial conditions, and small strains, define a finite linear plasticity before proceeding to the definition of an endochronic, finite thermoplasticity theory. In this case temperature as well as a deformation measure enter into a newly defined scalar parameter of process.

The book, written in German, is a precise and concise summary of the theory of constitutive equations in the spirit of nonlinear continuum mechanics with extensions to plasticity using the concept of endochronic time. It contains many evaluative remarks on the various approaches to continuum mechanics, e.g., the different treatments of thermodynamics, and is recommended to researchers in the field of nonlinear continuum mechanics. The inclusion of plasticity phenomena in nonlinear continuum mechanics is timely and important. However, it remains to be explored how well the precisely and consistently defined theoretical models represent real materials especially since viscoplasticity phenomena (the interaction of viscoelastic and plastic effects) are not included in the general theories of this book.

Marine Hydrodynamics. By J. N. Newman. The M.I.T. Press, Cambridge, Mass. 1977. Pages xiii-402. Cost $24.95.

REVIEWED BY L. LANDWEBER[6]

As stated in the preface, this book was intended to serve as a textbook for a first-year graduate course on the applications of hydrodynamics to marine problems. Somewhat less than half the book, Chapters 1–4, consists of a basic treatment of the mechanics of fluids. The theory is applied to the subjects of Lifting Surfaces, Waves and Wave Effects, and Hydrodynamics of Slender Bodies in the last three chapters. Reviewer's impression is that, in the main, the level of the material presented in the first part is well suited for a first year graduate course, but that, for much of the material in the second half,

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the student might need more preparation. Nevertheless, because of the consistently interesting and lucid style of the presentation, the book may inspire those students, who feel insufficiently prepared, to realize their need for more advanced study in Hydrodynamics to cope with marine problems.

The second chapter, on Model Testing, is essentially an application of dimensional analysis. Although a student would find the pragmatic treatment useful, he will have to look elsewhere for a careful statement of the Pi theorem.

The third chapter, Motion of a Viscous Fluid, seems to be the weakest part of the book. A statement in the Introduction that "the flow within the boundary layer is relatively insensitive to the form of the boundary" and the justification of the Froude hypothesis on the basis of boundary-layer theory, may lull the student into a disinterest in significant effects of viscosity, turbulence, and piezometric pressure gradients on the generation of secondary flows and vortices on the flow about a ship hull, and the important interactions between waves, and boundary layers and wakes. The vote of confidence in the Froude hypothesis gives aid and comfort to the commercial tanks which are ignoring the now well-verified result that the viscous resistance of a ship model depends on the Froude number.

The treatment of turbulent flow is very brief. Principally considered is the case of a flat plate, for which the two similarity laws, the law-of-the-wall, and the velocity-defect law, are presented. The implication that the former is valid only in the viscous sublayer should be corrected in pages 89 and 90. More serious for marine applications is the omission of treatments of boundary-layer stability, some turbulence theory, including mixing length and eddy viscosity, turbulent boundary layers with pressure gradients, closure equations, and turbulent wakes.

The treatment in Chapter 4 of the Motion of an Ideal Fluid is elegant and appropriate for the course. Reviewer suggests more emphasis on the orthogonality of functions encountered in the method of separation of variables, the presentation of the Lagally theorem (with which all students of ship hydrodynamics should be acquainted), and the generalized form of the Taylor added-mass formula (p. 143), which includes simultaneous translation and rotation.

The great merit of the book stems from the last three chapters, in which the author presents thoughts and procedures based on his own research contributions in these fields. Particularly, the 90-page chapter on Waves and Wave Effects fills a serious gap in the accessibility of ship-wave theory to the new graduate student.

Dynamics of Systems of Rigid Bodies. By Jens Wittenburg. B. G. Teubner. 7 Stuttgart 80, Industriestrasse 15, Postfach 801069, Germany. 1977. Pages 224. Price DM 74.

REVIEWED BY P. LIKINS[7]

Professor Wittenburg has provided in this small volume (224 pages) a compact but fairly complete and quite readable account of the dynamics of systems of rigid bodies.

The first third of the book is devoted to the development of background material in the kinematics and dynamics of simple rigid bodies and such special multibody systems as the gyrostat. This foundation is developed with care, and the book has a place in the technical literature on this basis alone (although most of the text deals with multirigid-body systems).

The mathematical language of the book is well suited to its subject, and the author develops his somewhat unusual but quite consistent vocabulary and notation at the outset. He makes extensive use of vectors and dyadics (referring to the latter as tensors), and of "matrices" whose elements are scalars or vectors. Thus the book must be read from the beginning, unless the reader is familiar with this notational school (to which in modified form this reviewer personally subscribes).

The chapter on kinematics is much better than most treatments of this subject, in that it is correct and consistent. Attention is focused on alternative modes of description of orientation (such as Euler angles, Bryant angles, Euler parameters, and direction cosines), and on the relationships of these variables to angular velocity.

A very brief chapter on the basic principles of rigid-body dynamics is included, with emphasis on Newton-Euler methods.

Solutions of the rather few classically tractable problems of rigid body dynamics occupy an important chapter in the book, since this material is rarely found in such complete and comprehensible form in one concise treatment. Special solutions for the gyrostat are included with the more conventional problems of tops and freely rotating rigid bodies.

Half of the book is devoted to a chapter on the development of equations of motion for general systems of rigid bodies, and in a final chapter a class of impact problems in such multibody systems is treated. The significance of the book must ultimately be judged by these two chapters. In order to measure this significance, one must answer two distinct questions: (1) How important is the subject? and (2) How successful is the treatment of the subject?

When Fischer produced a system for deriving equations of motion for multirigid-body systems in 1906, the world took little notice, for very good reasons. The equations were extremely complex, and there was no means at hand for their solution. In the middle 1960's, however, the digital computer had made these ordinary differential equations "solvable" and the space program had made these solutions useful and even necessary. The work of Hooker, Margulies, Roberson, Wittenburg, Velman, Russell, Kane, and others in this field was not ignored, and their results were widely used. Although for many (and perhaps most) modern applications the limitations of the multiple-rigid-body model have proven too severe, and newer formulations incorporating member flexibility have become ascendant, the multiple-rigid-body problem retains an important sphere of influence.

Professor Wittenburg is perhaps the most dedicated scholar of this subject in the world today. He has largely resisted the temptations that have drawn others into the consideration of flexible bodies, preferring to refine his treatment of multirigid-body systems. The material in the final chapter on collisions of such systems is uniquely his domain. His presentation of the subject, while not unique in its proper claim to elegance and completeness, is as worthy of textbook publication as any competing formulation.

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Impact Wear of Materials. By Peter A. Engel. Elsevier/North-Holland Publishers, P.O. Box 211, Amsterdam, The Netherlands and 52 Vanderbilt Ave., N. Y., N. Y. 10017. 1976. Pages xiv–339. Price $41.95.

REVIEWED BY FREDERICK F. LING[8]

The author set out to fill a hitherto neglected area of wear and has done an excellent job of exposition of the area of impact wear, methods of analysis and computation, and experimental verification. It is a welcome addition to the literature. After a review of friction and wear in Chapter 1, the author introduces in Chapter 2 the methods of percussive impact analysis including such items as numerical methods of impact stress analysis of what is called non-Hertzian problems and combined stress wave and Hertz-impact analysis. Chapter 3 deals with impact response of engineering surfaces including impact on elastic layers and thermal effects of impact. Chapters 4 and 5 discussed specific and general questions of erosion by solid particles. Experimental background of percussive impact wear is discussed in Chapter 6. Several methods are discussed in detail, including a ballistic impact-wear and pivotal hammering impact-wear experiments. Next, in Chapter 7, the zero impact wear model is discussed. A surface damage contribution factor β, is proposed. Chapter 8 deals with

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