

are concerned with dislocations and crystal boundaries culminating in describing studies of internal friction at elevated temperatures; Chapter 16 deals with relaxations associated with phase transitions. All of these later chapters involve extensive discussions of the considerable experimental studies in this area as well as of the theoretical models which have been worked on especially during the past 30 or so years. Thus the authors have performed as per their intent; they do relate the relaxations to atomic level processes. This comment also applies to the subsequent chapters which deal with thermal relaxations, internal friction in ferromagnetic materials and the interaction of an applied stress with the electrons in a crystal. The final chapter describes the four major experimental techniques for investigating anelastic phenomena. It provides a good useful starting point for those interested in establishing their own research activities in this area. Finally, there are seven appendices and a list of references well over 800 in number. All in all this book represents a considerable effort which has come off very well indeed.

Extremum and Variational Principles in Mechanics. By Horst Lippmann. Springer-Verlag, New York. 1970 publication. 238 Pages, Cost \$12.40.

REVIEWED BY E. F. MASUR⁹

This is another of a sequence of volumes consisting of a course of lectures by an internationally recognized authority at Udine, Italy. In the author's words, "Though there are plenty of excellent textbooks . . . dealing with or containing extremum and variational principles of the different fields of theoretical and applied mechanics, it is difficult to find one which covers all of them. This book will make an attempt, albeit incomplete to meet this need, . . ." This goal has been well achieved by the author, and the volume can therefore be recommended to anyone who already has a good understanding of the various subheadings of the subject but who is looking for a unifying and consolidating treatment.

The topics are introduced in logical sequence and present no surprises. After a general discussion of functional extrema in Chapter 1 the author discusses general classical principles of dynamics in Chapter 2. The cornerstone of his treatment is the virtual work principle, from which he proceeds, through the introduction of generalized coordinates, to work and energy, Hamilton's principle, and related formulations of variational principles. The transition from discrete systems to continua is somewhat heuristic but entirely convincing.

Chapter 3 contains a fairly classical introduction to the calculus of variations. In addition to the usual necessary conditions of stationarity the reader will find a readable discussion, fortified by simple applications, of the extremum conditions of Legendre and Jacobi. Conjugate formulations are introduced through the Legendre transformation, again with suitable examples.

The last chapter applies the principles developed in the previous chapters to continuum mechanics through the introduction of appropriate constitutive relations. Only elasticity, Newtonian fluids, and plasticity are treated in detail, but the coverage is sufficiently lucid to permit extension to other types of materials.

A good selective bibliography enhances the value of the book. The only drawback, in the reviewer's opinion, is its English style and notation, both of which deviate in many places from the norm. It is recommended that future volumes of this kind be subjected to more rigorous editing in order to enhance their readability and acceptance.

Subject to this one criticism the reviewer believes this to be a valuable addition to the relevant literature. Its ingredients are generally not new, but the mixture is instructive and rewarding.

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Metal Fatigue. By N. E. Frost, K. J. Marsh, L. P. Pook. Clarendon Press, Oxford. 1974. 499 Pages. Cost \$42.00.

REVIEWED BY DR. A. J. McEVILY¹⁰

The authors are associated with the National Engineering Laboratory in East Kilbride, Scotland, a leading center of engineering fatigue research. They have written a comprehensive volume in which current understanding of the processes of fatigue crack initiation and propagation provides a basis for a unified treatment of the subject. Principal chapters are: *Crack Initiation* (34 pages) with 3 out of 112 references dated 1966 or later; *Fatigue Strength of Plain Specimens* (90 pages) with 2 out of 210 references dating from 1966; *Effect of Stress Concentrations and Cracks on Fatigue Strength* (72 pages) with 9 out of 104 references since 1966; *The Growth of Fatigue Cracks* (91 pages) with 73 out of 178 references since 1966; and *Notes on Various Other Aspects of Fatigue* (162 pages) with 77 out of 455 references dating from 1966. This last chapter includes consideration of low-cycle fatigue, varying stress, mechanical working, surface treatment, pressurized cylinders, fretting, mechanical and welded joints, shrink-fit assemblies, rolling contact, accelerated testing, and statistical analysis. In addition there are a number of short appendices on definitions, fractography, testing machines, and test methods. Comprehensive author and subject indices are provided, and the volume is well illustrated throughout. With well over 1000 references the book will be a useful source of information.

From the data just given, it is interesting to note that the subject of crack growth has been the most active in terms of new developments in recent years. The authors themselves have been engaged in research in this area which may in part explain the greater emphasis on recent developments in this chapter as compared to the others. Activity in areas such as crack initiation has been relatively dormant, although there are still many questions which remain unanswered probably because we cannot really come to grips with them, such as the matter of the transition from initiation to propagation if indeed such a transition really exists. The extent of treatment of the various topics also reflects the authors' interests. The section on low cycle fatigue and bulk behavior does not receive as much consideration as might have been given by another author. Similarly, the topics of corrosion fatigue and fatigue at elevated temperatures with inclusion of environmental effects not treated in depth, although enough information is presented to provide an introduction to these topics. Omission of detailed treatments may reflect the current lack of understanding of these fatigue processes.

On an overall basis the book is a useful addition to the fatigue literature. It is clearly written and contains much information about fatigue in particular alloy systems, and so such should be of value to the design engineer. It should also be of value to the neophyte in need of an overview of the subject.

Elementary Engineering Fracture Mechanics. By David Broek. Noordhoff International Publishing, January 1974. 408 Pages. \$48.72.

REVIEWED BY JAMES R. RICE¹¹

Broek presents the elements of fracture mechanics as it is currently in use for the engineering analysis of crack growth in structural metals. The book is easily read. It requires no background beyond, say, first undergraduate courses in solid mechanics and materials science, and it would seem well suited as supplementary reading in more advanced courses. Also, engineers wishing to use fracture mechanics procedures for structural design or reliability studies would find all that is needed here, at least in introductory

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