basis of this limited usefulness of the second type of research that the first group has claimed the superiority of its own methods, although the latter have also been known to be ineffective when confronted with highly complex, but realistic design problems.

The current volume goes far toward establishing the practicality of the use of optimality conditions in the design of realistic structures. It is dedicated to Prof. William Prager, whose leadership and inspiration in the area of optimality research is unchallenged. Prager's example has been followed by a group of students, associates, and intellectual disciples, and the author is certainly one of the most prolific and productive within this group. It is altogether reasonable that he should be the one to compile the current volume, which is based to a considerable extent on his own work, although the work of others is freely discussed and generously acknowledged.

Flexural systems, that is, beams, slabs, etc., unlike discrete systems such as trusses, lend themselves to optimum design because of their continuity. Some discrete systems, such as grillages or fiber-reinforced slabs, may be treated as continua if the spacing of the elements is sufficiently close. For such systems there exists a substantial body of optimality conditions as well as their analytical or numerical solutions, and the current volume presents both a clear and comprehensive derivation of the theory and an up-to-date summary of available solutions. The author admits to a "definite bias toward . . . plastic design," but the problem of optimal elastic design is not neglected. Neither does the author neglect more recent developments (often his own), which include the cost of supports and the choice of location of these supports. Also, since fully optimally designed systems are often impractical for reasons of aesthetics or ease of fabrication, the subject of constrained optimization (that is, for example, the design of beams consisting of prismatic segments) is treated in full detail.

The first chapter covers basic concepts necessary for a study of optimality conditions, such as elements of variational calculus, definitions of convexity, general principles of mechanics, etc. Chapters 2–4 are devoted to optimal plastic design involving a single space variable (beams, rotationally symmetric plates, etc.) under single and multiple loads and for different levels of freedom of choice. Optimal elastic design is contained in Chapter 5. Genuine two-dimensional problems, notably grillages and fiber-reinforced plates, are covered in substantial detail in Chapters 6–8. In a sense such structures are equivalent to Michell trusses, and it is possible to establish general geometrical properties governing the spacing of the grillage beams or of the reinforcing fibers. However, unlike Michell trusses optimal grillages are entirely feasible, especially if optimization takes place under practical constraints. Upper and lower bound principles on optimal volumes facilitate the design even further. Chapter 9 finally discusses some practical design implications.

The book is written clearly and concisely. Important sections are often introduced by an excellent and comprehensive literature review giving a preview of salient results, which are then incorporated in the body of the section. Important equations and principles such as the Prager-Shield optimality criterion (on whose generalized form the author bases most of his developments) are set off in heavy print for easy reference, and special theoretical developments not essential to an understanding of the text are so identified. Some titles are somewhat convoluted ("partially prescribed cost distribution") and require an adjustment on the part of the reader, as do the figures which are too small for reading comfort. Conflicting theories and authors could have been refuted less elaborately if at all.

These are minor editorial criticisms, which are easily corrected in a second edition. All too often the search for strict optimality has been justified apologetically as a search for an ideal which, though impractical, can be used as a basis for comparison with more practical but imperfect designs. The current volume shows that for a broad class of problems the ideal and the practical can be combined. In the reviewer's opinion the book is therefore a landmark in the development of the theory and an indispensable tool in the hands of the designer.

Fracture of Brittle Solids. By B. R. Lawn and T. R. Wilshaw. Cambridge Solid State Science Series, Cambridge University Press. 1975. 204 Pages. $22.00 Clothbound. $10.95 Paperbound.

REVIEWED BY J. R. RICE[4]

This is a well-written introductory book which will appeal more to those interested in materials science than continuum and engineering aspects of fracture. The emphasis is on highly brittle solids such as ceramics and glasses and some metals. The presentation begins with the Griffith theory and with processes of crack nucleation, including dislocation models. This is followed by short presentations of elastic crack tip stress fields and essentials of Irwin's elastic fracture mechanics, of nonlinear fracture mechanics at the level of the J integral and Dugdale/BCS/Barenblatt models, and of dynamic fracture. It concludes with chapters on microstructural crack mechanisms in brittle materials and with two rather original chapters on discrete atomic lattice effects in fracture, including lattice trapping of cracks, and on kinetic processes of thermally activated, environmentally assisted slow crack growth in brittle materials, especially glasses. These latter sections may appeal also to more advanced workers in the subject.

The book does not develop theoretical topics at a fundamental enough level to serve as the only introduction of a serious student to the subject and no discussions of engineering fatigue and fracture analysis are presented. Also, the dynamic fracture section seems to rely on somewhat outdated work and an incorrect discussion is given of the energy release rates for crack branching. Nevertheless, the book is, when judged overall, very successful within the authors' chosen level and purview. It would, I believe, be excellent textbook material for coverage of fracture as part of an upper level undergraduate or perhaps beginning graduate materials science course on mechanical properties. Also, it would be very useful as supplementary reading for students of more mechanics and engineering centered courses on fracture. Its price in paperback form is refreshingly affordable: $10.95 in the United States, $7 or so at current conversion rates in the United Kingdom.

Classical Dynamics. By Donald T. Greenwood. Prentice Hall, Englewood Cliffs, N.J. 1977. Pages 337. Price $18.95.

REVIEWED BY R. M. ROSENBERG[5]

This book was written as a text in an advanced dynamics course taught in the University of Michigan.

The fundamental concepts of dynamics and a brief treatment of generalized coordinates, of constraints, and of virtual displacement and virtual work are presented in the first chapter. The next two chapters deal with Lagrangian mechanics including a derivation of Lagrange's equations, a section on integration theory and applications (to small oscillations, to forces derivable from a Rayleigh function, to impulsive forces and constraints, to gyroscopic forces, and to velocity-dependent potentials).

There follow three chapters on Hamiltonian mechanics beginning with a brief treatment of the variational fixed-endpoint problem in one and many dependent variables, Hamilton's principle for holonomic and nonholonomic problems, the theory of contemporaneous and noncontemporaneous variations, and a derivation of the canonical equations. The next chapter contains the Hamilton-Jacobi theory and the separability theorems of Liouville and Stäckel. The final chapter on Hamiltonian mechanics contains the theory of canonical transformations and introduces the Poisson and Lagrange brackets, in-

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finitesimal canonical transformations and some information on integral invariants.

The last chapter is an introduction to special relativity with sections on relativistic kinematics and dynamics, and accelerated systems.

Each chapter contains illustrative worked-out problems and is followed by a list of references for collateral reading and by (an average of 15) suggested exercises. The book concludes with a list of answers to a very large selection of "selected problems."

The book is attractive in typopgraphy and appearance, and the illustrations are well designed and executed.

If one would wish to question certain aspects, they would be that the worked out examples are often too simple to be comensurate with the theoretical development, that the canonical transformations follow, rather than precede, the Hamilton-Jacobi theory which has the object of finding generating functions of canonical transformations, and that the bracket symbols, so useful in integration theory, come some 40 pages later. Moreover, perturbation theory utilizing infinitesimal canonical transformations is not presented even though it might have been of interest to the engineer. However, these criticisms merely show how the reviewer might have written such a book, and that is not his function.

Greenwood's is an excellent book and an important addition to the literature. This is true in part because it is addressed to engineers, not to physics students preparing to study quantum mechanics. But its overwhelming virtue is that its content is correct and clear. Greenwood takes pain to define unambiguously concepts like "generalized coordinates," "degrees of freedom," "virtual displacements," etc., rather than shroud them in uncertain verbal descriptions. He points out the important distinction between results which hold for holonomic systems only and those which hold for nonholonomic ones as well, and he illustrates by example the mistakes which result from ignoring the distinction. It is surprising how many misconceptions abound in the recent literature dealing with topics in advanced dynamics, and it is a pleasure to see a book which dispells, not perpetuates, them. In this reviewer's opinion, the need for a text like Greenwood's *Classical Dynamics* has existed for some time, and his book fills that need very well.

Selected Topics in Wave Propagation. By Peter J. Chen.Noordhoff International Publishing, 198 Ash Street, Reading, Mass. 01867. 1976. Pages 288. Cost $42.

REVIEWED BY T. C. T. TING[6]

There are two topics selected in this book—Shock Waves and Acceleration Waves. Although both shock waves and acceleration waves can be looked at as the propagation of singular surfaces across which some physical quantities and/or their derivatives suffer discontinuities, they are mathematically quite different. For an acceleration wave, the singular surface is necessarily a characteristic surface. Therefore, the amplitude of the discontinuity in acceleration is governed by the Bernoulli differential equation which can be integrated once the region ahead of the acceleration wave is known. For a shock wave, the singular surface is in general not a characteristic surface except when the system is linear. Therefore, even though a differential equation governing the discontinuities across a shock wave can be written, the equation cannot be integrated because it requires information in the region in front of, as well as behind, the shock wave. In reading this book, one should keep this point in mind.

The basic theories of propagating singular surfaces are presented in Chapter 1. The definition of shock waves and acceleration waves are given in Chapter 2 along with the kinematical and dynamical relations which govern the discontinuities across a singular surface. The general behavior of the solution to the Bernoulli differential equation is examined in detail in Chapter 3. This is the differential equation which determines the growth or decay of the acceleration waves. Shock waves and acceleration waves in three-dimensional elastic fluids are discussed in Chapter 4. The remaining 6 chapters of the book deal with one-dimensional shock waves and acceleration waves in various materials. Materials with memory are discussed in Chapter 5, laminated composites in Chapter 6, inextensible elastic materials in Chapter 7, inhomogeneous elastic materials in Chapter 8, chemically reacting mixtures in Chapter 9, and diffusing mixtures in Chapter 10. In each chapter, both acceleration waves and shock waves are studied except for the chapter on composite materials where only the acceleration waves are considered and for the chapter on inextensible elastic materials where acceleration waves and progressive waves are examined.

The book is well written. Heavy references are made to Truesdell and Toupin on "The Classical Field Theories" in *Handbuch der Physik*, Band III/1. This is particularly so in the first two chapters where the basic theories are developed. While the results presented in the first four chapters are quite general and are not limited to one-dimensional waves, the book essentially collects some published work on one-dimensional shock waves and acceleration waves. It will be a valuable reference book for researchers who are interested in shock waves and acceleration waves in one-dimensional media.

Principles and Practice of Laser-Doppler Anemometry. By F. Durst, A. Melling, and J. H. Whitelaw. Academic Press, New York. 1976. Price $29.25.

REVIEWED BY C. P. WANG[7]

Laser-Doppler anemometry is a very powerful experimental technique for measuring velocity components based on the use of light scattering and Doppler's principle. It allows measurement of the local, instantaneous velocity of tracer particles suspended in the flow and hence does not disturb the flow. Because of its large dynamic range, versatility, and noninterference, Laser-Doppler anemometry has been widely used in applications such as measuring the local velocity in wind tunnels, low-speed rotating flows, high-speed high-temperature combustion flows and jet exhausts, as well as remote probing of atmospheric wind velocity and the trailing vortex of airplanes.

This book makes an important contribution to the practice of Laser-Doppler anemometry. It serves as a convenient handbook or source of references on almost all aspects of Laser-Doppler anemometry. It covers a wide spectrum of topics including geometrical and physical optics, light scattering by particles, various optical arrangements various signal processing techniques, and many practical considerations. It should be very useful for students, engineers, and research workers in fluid mechanics.

However, it is rather unfortunate that the authors failed to mention the fundamentals of Laser-Doppler anemometry, namely, optical mixing spectroscopy or light beat spectroscopy, and excellent review papers. In particular I regret not seeing those by Benedek (in *Polarization, Matter and Radiation*, Presses Universitaires de France, Paris, 1969), Cummins and Swinney (in *Progress in Optics*, Vol. VIII, North-Holland Publishing Co., Amsterdam, 1970), and Chu (*Laser Light Scattering*, Academic Press, New York, 1974).

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