relation to the economics of maintenance of modern railroads.

As one reads through this book, one realizes that the contents represent a good example of the philosophy that if the goals are ambitious, they may sometimes be successful. In the reviewer's opinion, this volume contains one of the best summaries of the field of contact mechanics applied to rail/wheel systems and must be read if one wishes to familiarize oneself with the current research.

The book consists of six parts covering research that includes the mathematical, experimental and design aspects. The flavor and scope of the book can be best deduced by a listing of the contents, which are as follows:

(Part I) "Elastic Contact Analysis"—This part has an introductory paper by Goodman, analytical papers by Gladwell and Greenwood, and an analytical-numerical paper by Kikuchi.

(Part II) "Developments in Contact Mechanics"—Fremond discusses adhesion in the contact; Johnson, inelastic contact; Tevaarwerk, traction in lubricated contacts; and Lawn and Wiederhorn, brittle fracture. Kalker relates two numerical algorithms for contact elastostatics and Süsskind ends the chapter with a tribute to H. Hertz.

(Part III) "Wheel/Rail Mechanics: Applied Theory"—The reality of the wheel/rail applications aspects begin to appear at this point. The wheel/rail contact geometry is detailed by Duffek; its consequences for the surface and subsurface stresses are given by Paul; tangential force-creepage in theory and practice is discussed by Pearce and Rose. Dynamic loading of rails at corrugation frequencies is mentioned by Grassie, et al., and the estimation of creep coefficients by testing is made by ul-Haque and Law.

(Part IV) "Rail/Wheel Wear and its Reduction"—Papers in this section are concerned with the wear and fatigue of the rail/wheel tribosystem. Ghonem, et al. relate observations of rail wear for heavy haul systems, while Steele and Devine discuss gage face wear resistance. Caldwell discusses the contribution of self-steering trucks to rail and wheel wear reduction and Gilmore, the use of conformal wheel profiles to develop a light steerable transit truck. Roney discusses rail wear from the economic viewpoint.

(Part V) "Laboratory Studies of Rail/Wheel Tribosystems"—This section is devoted to experiments performed at various laboratories throughout the world. Some of the experimental studies are as follows: Krause and Poll on the influence of real material and system properties on the traction/creep rolling contact relationships; Kalousek, et al. on the effects of lateral creepage on wear; Ohyama and Maruyama on traction and slip at higher speeds; Clayton, et al. on the results of their studies of surface damage phenomena; and Bugarcic and Lipinsky on their research on two newly developed rolling friction test rigs.

(Part VI) "Design Aspects of Rail/Wheel Contact Mechanics"—The end product of the research of the previous sections is the practical design, which is discussed in papers by Lyon and Weeks on the design of bogies for low wear, by El Maraghy on the design of a power braking railway coach, by Barwell on wheel to rail adhesion, by Elkins on the effect of modifying suspension and wheel profile, by Mufti and Dukkipati on the dynamics associated with a certain simulator, and by Kumar, et al. on the IIT-GMEMD Wheel Rail Simulation Facility to study dynamic effects.

A seventh part summarizes the symposium through panel discussions on the following topics: Contact Mechanics Fundamentals, Rail/Wheel Wear and Wear Reduction, Laboratory Studies of Rail/Wheel Tribosystems, and Design Aspects of Rail/Wheel Contact Mechanics.

Although one has to have a relatively high level of sophistication in mathematics, mechanics, and metallurgy to appreciate all aspects of this book, it represents an invaluable source for the investigator wishing to do useful research in this area. It serves as a good introduction to the mechanics problems specific to the railroad industry and to the terminology used there.

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**Theory of Viscoelasticity, An Introduction, 2nd Edition.** By R. M. Christensen. Academic Press, New York, 1982. 364 Pages. Price $45.00.

**REVIEWED BY L. B. FREUND**[6]

This is a significantly revised and updated version of the first edition of Dr. Christensen's book which was published in 1971. The material which appeared in the chapters of the first edition has been revised and expanded to account for developments in the field during the intervening decade. The overall treatment of the mechanics of viscoelastic materials has been expanded to include discussion of recent progress in three principal areas, namely (*i*) mathematical approximations which have been found useful in practical applications of the theory, (*ii*) solution of boundary value problems in linear viscoelasticity for which integral transform methods do not apply (e.g., transient contact and crack growth problems), and (*iii*) the theory of viscoelastic materials with nonlinear mechanical response.

The book is intended mainly as a text for a graduate level course for students with some background in the theory of elasticity and the methods of mathematical physics. It could be used effectively in this way because the coverage is broad, many literature references are included, and each chapter is followed by a set of exercises to guide further development of the text material. Because numerous references to the recent literature are given, and because some of the material included in the current edition is still receiving attention from the research community the book should also have value as a research reference volume.

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