
REVIEWED BY J. F. BOOKER

Selections from the author’s Preface best suggest the ambitious scope and organization of this text:

“Tribology is defined as the science and practice of friction, lubrication and wear applied to engineering surfaces in relative motion. . . . This book attempts to deal with the whole field of tribology in a single volume. . . . Because of the immense scope of the subject matter, omissions must inevitably occur . . . .”

Consistent with its title, “the contents of the book have been divided into two sections dealing broadly with principles and applications respectively.”

Beyond that is a fairly even division into 16 chapters:

“Chapter 1 deals with the immense scope of tribology and range of applications in the modern world of technology. Chapter 2 is devoted entirely to the evaluation and measurement of surface texture. Chapters 3, 4 and 5 present the fundamental concepts underlying the friction of metals, elastomers and other materials respectively. The principles of hydrodynamic lubrication are dealt with briefly in Chapter 6, and the mechanisms of boundary and elastohydrodynamic lubrication receive a more comprehensive treatment in Chapters 7 and 8 respectively. Chapter 9 is a generalized treatise on wear and abrasion phenomena in metals and elastomers. Whereas surface interactions are dealt with exclusively throughout Chapters 2 and 8, internal friction in solids, liquids and gases is identified and explained in Chapter 10. Chapter 11 is an abbreviated yet thorough treatment of experimental methods used in tribological studies. The remaining five chapters in the book are devoted to specific applications, including manufacturing processes, automotive applications, transportation, locomotion, bearing design and miscellaneous.”

Thus this is definitely not another text on lubrication masquerading under a broader title; less than ⅔ of the book is devoted to that topic and its manifestations. Considering its length, the treatment of lubrication is remarkably complete, perhaps because it settles for presentation rather than derivation of the Reynolds equation, though the equation of fluid motion is later developed in some detail. (Unfortunately, the “wedge” term of the Reynolds equation is incorrect as presented, and the error is repeated in later developments of principles and applications.)

An extensive index contains about 1000 subject entries. By contrast, the modest list of References has fewer than 90 citations. Two-thirds are from the sixties, reflecting the field’s explosive expansion in that decade. (Unfortunately, apart from publications and private correspondence of the author, nothing more recent appears.) Nearly all References are in the English language, though only four ASME papers are noted, and these without Transactions citations. (Any bias is understandable, considering that the author’s affiliation is University College, Dublin.)

Typography is clear and on substantial paper. Line drawings are numerous and generally clear. A handful of photographs of indifferent quality printed on coated paper are included as well.

“Written from the point of view of the mechanical engineer,” the book is avowedly designed as a text, though it contains no problems or questions for students. It should be thoroughly readable for undergraduates, since most developments are fairly descriptive and the level of mathematics is minimal.

There is an admirable absence of unit-dependent “design” equations. Units, when they appear at all, are almost invariably metric, though not always in approved SI form. (The confusion between force and mass will persist indefinitely in the external world; students may as well find it in their texts as elsewhere.)

Certainly this text should serve as an enthusiastic introduction to the breadth of tribology, as seen through detailed discussion of such diverse and unconventional topics as the friction of skin and natural joints, as well as through very brief encounters with the wear of circulated coins and the locomotion of caterpillars.


REVIEWED BY S. M. ROHDE

This book is a research monograph which deals with rational finite element bases. As indicated in the preface, rational in the title refers both to the ratio of polynomials and to the fact that the basis functions are derived in a rational (logical) manner from the geometric properties of the elements. Likewise the word basis also has a dual meaning—the usual function analytic meaning as well as a logical meaning in providing a basis for finite element computation.

Chapter 1 deals with the patchwork (piecewise) nature of finite element bases. The usual wedge and pyramid functions associated with triangular elements are studied as is the bilinear wedge associated with rectangular elements. “Polycons,” closed figures in the real plane which are bounded by segments of lines and conics, are defined, classified, and some of their properties noted. The polygon is clearly a special case of a polycon. Next, properties required of wedge functions over “well set” polycons are listed. Isoparametric coordinates are briefly discussed in a digression and related to rational basis functions over polycons. Finally, the generalization to figures with sides of higher order or “polypols,” and to three dimensional elements is briefly discussed. A polypol is defined as a closed planar figure all of whose sides are algebraic curves.

Chapter 2 begins by demonstrating that polynomials are inadequate for constructing wedge functions for arbitrary quadrilaterals (other than parallelograms). The latter motivates the selection of rational functions as possible candidates for wedge functions. Quadrilateral bases are derived and some examples given. A section on projective coordinates which allows for a better understanding of the nature of rational approximations over quadrilaterals is included. Finally, the “natural” extension of the quadrilateral wedges to other convex polygons is discussed and shown to be the wrong one.

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Chapter 3 discusses the construction of rational wedges for selected polycons. In particular, a quadrant of a disc and a pentagon are considered.

Chapter 4 discusses some concepts from algebraic geometry. The latter field is concerned with the study of algebraic curves, and the characteristics and nature of their intersections. Earlier in the book some notions from this field were also discussed. This chapter is included because it provides the "machinery" necessary for the subsequent construction of rational wedges. In particular, in Chapters 5 and 6, the theory given in Chapter 4 is used to construct rational wedges for polycons and polypols.

The extension to three dimensions is discussed in Chapter 9. The "polypoldron," a three dimensional analog of the polydron, is introduced. The two dimensional basis function construction derived earlier in the book is extended to three dimensions in this chapter.

Chapter 8 discusses the use of irrational wedges as bases for approximation over ill-set polypols.

As those familiar with finite element computation are well aware of, the quadratures involved in evaluating the elements of a stiffness matrix are of central importance. Even with polynomials these computations can be tedious and accuracy is of importance. Chapter 9 addresses this question for rational approximations. Wedge quadrature is first defined. The concept of "consistent" quadrature is discussed as well as the "patch test." Triangle averaging, a procedure familiar to finite element analysts, is generalized to "mosaic" discretization. The remainder of this chapter is concerned with "harmonious" discretization and the question of "optimum" bases over elements. Numerical comparisons between different discretizations are given.

Chapter 10, concluding the monograph, discusses some potential applications for the rational basis functions. The parallel is made that the increased modeling flexibility afforded by rational elements over isoparametric elements is analogous to the increased flexibility afforded by isoparametric elements over triangular or parallelogram elements. The author indicates, however, that very little experience using these elements has been collected. Hence, the practical utility of this approach remains to be demonstrated. Potential applications in the nuclear reactor field are alluded to.

In conclusion, this monograph discusses a current field of finite element research. It is primarily suitable for applied mathematicians who are interested in pursuing research in the area of rational finite element bases.