

Preface

Since the turn of the millennium, it has become common in North American engineering schools and colleges to combine the traditional undergraduate offerings in rigid-body statics (usually called simply “statics”) and deformable-body mechanics (known traditionally as “strength of materials” and more recently called “mechanics of materials”) into a single introductory course in solid mechanics. Since the textbooks for both of the traditional courses were often the work of a single author or group of authors, the publishing world has found it expedient to create textbooks for the new course by sequentially melding pieces of the existing books, sometimes (but not always) acknowledging the origin by dividing the book into halves titled *Statics* and *Mechanics of Materials*.

When a course of the new type was introduced in the College of Engineering of the University of California at Berkeley, we felt that it would be more sensible to treat the material in an integrated way, proceeding from first principles to applications, and we found that the available textbooks forced us (and the students) to move around in a labyrinthine fashion. This experience moved us (JL and PP), with the encouragement of our colleagues, to consider writing a book in which the material would be presented methodically. After 3 years of work we are ready to present the result to the world of engineering education, in the hope that others teaching introductory solid mechanics might see the subject in a light similar to ours.

The traditional topics of “statics” are covered in the first three chapters, whose respective subjects are (1) forces and moments (including the necessary mathematical preliminaries and a thorough discussion of dimensions and units); (2) equilibrium (beginning with the equilibrium of particle system as studied in elementary physics, and including friction; the concept of work, both real and virtual; and the method of sections in its general sense); and (3) articulated assemblages of rigid members, beginning with a general discussion of the method of joints and covering trusses, frames, machines, chains, and cables (with a brief discussion of the relation between cables and arches).

The middle third of the book is devoted to the fundamentals of the mechanics of deformable solids: a chapter each on stress, deformation and strain, and elasticity. All these concepts are developed to their full three-dimensional

aspect, and while only isotropic elasticity is studied in depth, care is taken to define isotropy precisely, and examples of anisotropic elasticity are given for illustration. The chapter on stress includes a section devoted to what we call “simple stress states,” that is, the special cases in which stress can be determined by statics alone, and stress-based design is introduced as a consequence. Stress and strain transformations, including the determination of principal axes, are discussed from both the geometric and the algebraic points of view. In the chapter on deformation and strain, virtual displacement and virtual work in continua are discussed in detail, both in general and in special cases.

The chapter on elasticity includes sections on static indeterminacy (with introductions to the force and displacements methods), elastic energy (including the classic energy principles), and thermoelasticity. The former two sections include a basic introduction to the finite-element method.

The elongation of axially loaded elastic bars is also covered in a section of the elasticity chapter, since the relative simplicity of the problem does not warrant a chapter of its own. The other classic engineering applications of solid mechanics are, on the other hand, covered separately in subsequent chapters: torsion, bending (a chapter each for the basic theory and for additional topics), and buckling.

Singularity functions, whose use is suggested optionally in several contexts (and illustrated in conjunction with bending), are covered in the appendix.

A chapter discussing, in a mostly qualitative way, inelasticity (including a description of various test methods) and material failure (including failure mechanisms and failure criteria), as well as structural failure (including an introduction to ultimate-load analysis), concludes the book.

While the book was conceived with the intent of serving as a text for a one-semester (or one-quarter) course, we have found, after completing it, that the coverage is, in most areas, far more thorough than might be warranted in such a course and might even serve the needs of a two-term course. With the time constraint of one term, it is likely that several topics or subtopics may have to be omitted because of time constraints. Such omissions are, of course, at the judicious discretion of the instructor, and we will not presume to indicate (as is often done, for example, with asterisks) which topics are to be considered less important than others. We believe that the structure of the book lends itself to a smooth coverage of the material in spite of possible omissions.

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An Integrated Approach

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