to a time before the development of structured constructs for loop control banished the GOTO from modern programming practice. Some of the tutorial materials dealing with specific software packages read as if they are actually laboratory handouts and as such should probably have been included as appendix material, if at all. Referring to "giga" as a "billion" (page 355) is OK for material limited to distribution in the US, but not for worldwide distribution. Stating that protons and neutrons are "elementary" particles (page 668) in the same sense that the electron is is bothersome. Similarly, stellar "color" is related to the temperature of a star, not its brightness (page 306). The use of 'he' to refer to the reader should have been avoided. Distractions like these should have been caught by the editors or reviewers prior to publication.

This book can be considered for use as a text in a laboratory-based course in computational science, but its selection would be dictated by whether or not the specific hardware and application software discussed provides the necessary fit with the course. If selected, its use would have to be supplemented appropriately with questions, exercises and projects developed by the instructor or, in part, obtained from the authors.

**Ralph L. Place**
*Ball State University*
*Muncie, Indiana*

## Mechanics of Materials

David Roylance
*Wiley, New York, 1996. 315 pp. $75.95 hc ISBN 0-471-59399-0*

## Mechanics of Materials

Roy R. Craig Jr
*Wiley, New York, 1996. 752 pp. $92.95 hc ISBN 0-471-50284-7*

The title "Mechanics of Materials" has been used to describe books on beam theory and books bridging materials science (the development of new materials) and mechanics (as applied to solving structure and infrastructure problems). David Roylance's *Mechanics of Materials* covers beam theory, failure theories and fracture, while Roy Craig's book of the same title covers beam theory in depth.

Roylance's book is well written and well organized, and it contributes a nice overview of the field. Its focus, on tying mechanical behavior to microstructure, is the appropriate approach for this subject; its introduction of finite elements, strain gauges, moiré patterns and photo-stress is also appropriate. Experimental and computational techniques should be included with the analytical approach to the mechanics of materials; unfortunately, I found the mathematics here to be presented rather than developed; the book contains so much material in so abbreviated a manner as to lose substance.

Roylance's book is not suitable as an undergraduate text for teaching beam theory, nor is it suitable for a course in mechanical behavior of materials that would be taught from a book like Norman Dowling's *Mechanical Behavior of Materials* (Prentice Hall, 1993). It might, however, be suitable for a senior-year elective course in mechanics.

In general, the mathematics and techniques used in Roylance's text are relatively advanced and not sufficiently well developed to teach them to undergraduates. For example, Roylance introduces and then derives the biharmonic equation in just a few pages; cylindrical and elliptical coordinates and complex variable techniques and Airy's stress function are similarly introduced in a few pages. Such brief presentations of advanced material are insufficient for the student to gain an understanding of the underlying physics. I agree that it is good to expose students to advanced techniques, however, the techniques must be carefully developed in an undergraduate text or the students will simply be lost. By comparison, the development in this book is even more brief than that in Lawrence Malvern's *Continuum Mechanics* (Prentice Hall, 1969). I would consider using Roylance's book for a senior elective after a student has taken beam theory and a course that covers the material in Dowling's book.

Roy Craig's *Mechanics of Materials*, by contrast, covers a section of the core of the undergraduate curriculum in mechanical, civil and aerospace engineering. The subject of the text is of fundamental importance in these disciplines, and a textbook of this caliber is certainly needed.

As a field, the mechanics of materials (also called mechanics of deformable bodies or strength of materials) is a mature subject, and thus no ground-breaking advances are expected. However, Craig's book does represent a contribution to undergraduate teaching. Stephen Timoshenko and James Gere's *Mechanics of Materials* (PWS Publishing, 1990) was a very good book in this area. Craig's treatment is similar in format to theirs, but much improved.

When undergraduates step into this subject area, they are getting their first exposure to techniques of mechanical analysis and design. The figures throughout Craig's text are not the typical schematic idealized problems. Rather, they present mechanical parts of engineering structures and machines. Many other excellent pictures are used to illustrate the techniques of experimental mechanics, which is extremely useful to an instructor in motivating the students.

The organization of the material in Craig's text lends itself well to teaching. The section on stress and strain builds systematically all the way up to the generalized Hooke's law for isotropic materials. The discussion of special cases then follows naturally (uniaxial, multiaxial, torsional and so on). The chapter on stress and strain transformations is particularly nice. Several motivating examples lead up to the development of Mohr's circles, but Craig does not stop here. Principal values and directions are presented, and the general approach using direction cosines is used. The chapter ends with application of the transformation laws to strain gauges. (Contrary to popular belief, the finite-element method has not eliminated the need for and use of wire/foil strain gauges.)

The final chapter, on failure theories, is too brief to do anything but mention that they exist. This is the subject of other books, Dowling's *Mechanical Behavior of Materials* for example, or such more advanced books as Jean P. Lemaitre and Jean-Louis Chaboche's *Mechanics of Solid Materials*, (Cambridge U. P., 1994), which are beyond the scope of an undergraduate course. This chapter could have been left out without detracting from the book.

Roy Craig is well known and respected by the structural mechanics community and has already written one successful textbook, *Structural Dynamics—An Introduction to Computer Methods* (Wiley, 1981) in a related field. It has been a pleasure to review his latest book.

**Christopher S. Lynch**
*Georgia Institute of Technology*
*Atlanta, Georgia*

## Lasers and Electro-Optics: Fundamentals and Engineering

Christopher C. Davis
*Cambridge U. P., New York, 1996. 742 pp. $120.00 hc ($44.95 pb) ISBN 0-521-30831-3 hc (0-521-48403-0 pb)*

Christopher Davis's *Lasers and Electro-Optics* is a comprehensive undergraduate text that provides a broad but detailed introduction to the basic physics and applied underpinnings of lasers and modern optical systems. As such, the book should be useful in support of the growing practice of exposing undergraduate engineering and applied physics students to laser physics, modern optics, optoelectronics and optical engineering.

*Lasers and Electro-Optics* is well written and appears to have been tested as a text. The author's success in treating most of the topics at essentially the same level—that of the advanced undergraduate—is noteworthy. The book's many diagrams are carefully rendered, and most chapters offer homework problems and bibliographies.

One of Davis's aims was to write a book that would require only minimal prior exposure to electromagnetism and no previous course in quantum mechanics; he seems to have succeeded on this front. In fact, the profusion of topics treated, and Davis's tendency to provide detailed derivations of many important expressions, make this 700-plus-page book rather encyclopedic—an aspect that has both advantages and disadvantages.

*Lasers and Electro-Optics* begins with the usual array of topics, such as spontaneous and stimulated emission, line broadening, optical amplification and saturation. After relating these topics to ruby and helium–neon lasers, the author moves on to optical cavities, coupling, diffraction, coherence and mode considerations. The middle section of the book concentrates on design and operational considerations of optically pumped solid-state lasers, gas lasers, molecular lasers and dye and semiconductor lasers. The book then shifts to a treatment of various optical systems, Gaussian beams, fibers, electro-optics and acousto-optics, nonlinear optics, detectors and coherence theory. All in all, there is enough material in this book for a two-semester course.

As one might expect from the book's title, this text has an engineering flavor; the choice of topics and emphases seems to be driven largely by the perceived needs of the contemporary electrical or electro-optical engineer. As for level of presentation, Davis's book resembles William Silfvast's new text, *Laser Fundamentals* (see accompanying review on page 53). On the other hand, *Lasers and Electro-Optics* is pitched at a substantially lower level than Anthony Siegman's *Lasers* (University Science Books, 1986) or Peter Milonni and Joseph Eberly's *Lasers* (Wiley, 1988). If one prefers a text that includes many derivations at the expense of brevity, the Davis book is an attractive alternative to Amnon Yariv's *Optical Electronics*, fourth edition (Saunders College, 1991).

In summary, *Lasers and Electro-Op-*

*tics* is well conceived, well written and nicely organized. It represents a valuable addition to the collection of undergraduate texts available today in laser physics.

**John R. Brandenberger**
*Lawrence University*
*Appleton, Wisconsin*

# Newton's *Principia*: The Central Argument

Dana Densmore
*Green Lion P., Santa Fe, N.M., 1995. 465 pp. $45.00 hc ($26.95 pb) ISBN 1-888009-01-02 hc (1-888009-00-4 pb)*

Dana Densmore of St. John's College in Santa Fe, New Mexico, clearly identifies in her *Newton's* Principia*: The Central Argument* what she considers to be the *Principia's* core concern: "Buried within this heap of brilliant propositions," she writes, "is a central jewel, the establishment of universal gravitation and its use to demonstrate the elliptical orbits of the planets, which constitutes the main argument of the *Principia*." There is much more to the *Principia* as a work of rational mechanics than this selection, however central, but it certainly is a sufficient introduction to the *Principia* for any student.

The strength of this text as a guidebook to these selected portions of Newton's *Principia* lies in the teaching tradition from which it stems: St. John's College, founded in 1696, just nine years after the publication of the first edition of Newton's *Principia*, and its distinctive curriculum centered on "great books." The college's flyer on the World Wide Web (http://www.sjca.edu) sets out the institution's pedagogical goal: "Through the reading of original texts, students reflect on the great questions of the Western tradition from ancient Greece to modern times."

The intent of Densmore's guidebook is to involve the student actively in Newton's analysis; Newton's tendency to omit intermediate steps in the analysis offers ample opportunity for such involvement. To that end, the guidebook is designed on three levels: The first consists of the translation, by W. H. Donahue, from Newton's Latin text itself, and it is distinct from the author's notes and expanded proofs. The student can thus attempt to follow Newton without intervention. The second level offers minimal help in the form of notes that alert the student to possible omissions and potential pitfalls in Newton's presentation and then challenge the student to fill in any steps that are missing. The third level provides an expansion of Newton's sketch of the demonstration and offers a step-by-step demonstration of what Densmore thinks "Newton would have given as a complete proof."

Throughout the guidebook, the student is urged to attempt the demonstration before reading these extended notes, but the notes are always there as a safety net when needed. The challenge to understand Newton's analysis excites the author, and she has written the guidebook to communicate that excitement to the student.

On what level and in what time frame is such a communication possible? Densmore appears to gear the guidebook toward an upper-division undergraduate course, when she notes that "the Muses of this guidebook have been the students in my junior mathematics tutorials [at St John's]." Moreover, it is evident that some knowledge of Euclid's *Elements* is assumed, in both technique and substance. Specific references to the *Elements* are given, however, for those less familiar with Euclid. The time span for the course is a semester, although the author notes that "those who have more than a semester to spend on Newton can profitably work . . . out some of the intriguing side paths [not covered in the guidebook]." I can only look with envy at an institution such as St. John's that is willing to offer a semester to the *Principia*, and with absolute admiration at those that offer more.

There is much more that could be said about the many strengths (and some weaknesses) of this work. It is a scholarly work, but the mind of Newton offers a challenge even to the most dedicated of scholars. In an attempt to avoid a modern reading, Densmore may well have imposed a Euclidean view that is more stringent than is consistent with Newton's thought. But that is a side of Newton often neglected and thus one that deserves attention.

Although the strength of the guidebook is the author's demand for attention to detail, this demand provokes another problem, which is exacerbated by her choice of the much expanded third edition of the *Principia* in place of the first edition. The reader must excavate a vast amount of material to uncover "the jewel buried within this heap of brilliant propositions" that she argues is located in Book Three. It is not a journey for the weak in heart. It will be an education, however, for the brave instructor as well as the courageous student. I strongly encourage interested faculty to generate a seminar that will devote a semester to this challenge.

Use Densmore's challenging guidebook, but also get a copy of the entire *Principia* (a new translation by I. Bernard Cohen is soon to be published by the University of California Press). Hold Densmore's analysis of Newton's opening lemmas up to your knowledge of the calculus that has evolved. Follow her insights into and criticisms of Newton's demonstrations. Look with care at the curvature lemma (lemma 11) and at the "alternate" demonstrations, which she has deleted. Form for yourself a view of the wonderful world of Newton's thoughts on dynamics—a world far removed from that which most physicists now present in their lectures on Newtonian mechanics. Densmore has provided a guide to that world, but you must make the journey yourself.

**J. Bruce Brackenridge**
*Lawrence University*
*Appleton, Wisconsin*

# Understanding Relativity: A Simplified Approach to Einstein's Theories

Leo Sartori
*U. of Calif. P., Berkeley, Calif., 1996. 367 pp. $50.00 hc ($19.95 pb) ISBN 0-520-07986-8 hc (0-520-20029-2 pb)*

Leo Sartori's *Understanding Relativity* is a treatment of relativity at an undergraduate level. It uses some math—mainly algebra with a slight amount of calculus—and is aimed at a freshman or sophomore course. Sartori's text is competent, it has merit, but it is simply one that I personally do not like overly much.

A text should inspire, teach, be a reference, supply problems. It should be attractive to both student and professor. It is to be used, possibly with other references, in a course, and the course should have well-defined prerequisites, methods and goals or objectives, all of which should be reflected in the text. (I contrast Sartori's book with the second edition of *Spacetime Physics: Introduction to Special Relativity* by Edwin F. Taylor and John Archibald Wheeler [Freeman, 1992], which I prefer.)

Sartori covers a fairly standard list of special-relativity topics, although not in what I would call a simplified manner. There are some oddities: He uses Loedel diagrams, in which orthogonal axes represent *ct* in one inertial frame and $x'$ in another. I feel these diagrams confuse more than teach; I feel, for example, that they