BOOKS

Special Focus: A Selection of Undergraduate Textbooks

Laser Fundamentals

William T. Silfvast
Cambridge U. P., New York, 1996. 505 pp. $89.95 hc ($39.95 pb) ISBN 0-521-55424-1 hc (0-521-55617-1 pb)

Reviewed by William B. Bridges

Given the great number of books on lasers already in print, one might wonder what new could be said in an introductory text written more than 35 years after the "first light" of the laser. As surprising as it may seem, William T. Silfvast's *Laser Fundamentals* does indeed provide a fresh approach. It may be that Silfvast's three decades of hands-on laboratory experience in lasers at AT&T Bell Laboratories, primarily with gas and metal-vapor lasers, makes the difference. Clearly, this book was written by an experimenter.

The authors of most popular laser texts that spring to mind are life-long academics whose experimental work is done primarily by their students. Silfvast, however, now at the University of Central Florida, is a relative latecomer to the academic world, so his laboratory exploits are first- rather than second-hand. He was the discoverer of many vapor ion lasers, beginning with the helium–cadmium ion laser—which he developed in his graduate years—a laser that is still a commercial product 30 years later. This intimate acquaintance shows through, especially in the problems for the student, which are largely the kind of numerical calculations an experimenter has to make in considering the practicality of an experiment or the details in setting one up. There are none of those usual, long derivations that result in a formula but stop short of plugging in numbers.

Laser Fundamentals is appropriate for an advanced undergraduate or first-year graduate course. There is an extensive background review of radiation physics, properties of materials and quantum mechanics at the beginning of the book, making it particularly useful for students who have had only beginning physics—electrical engineers for example. Indeed, 200 pages go by before the "conditions for producing a laser" appear in chapter 7! Those 200 pages by themselves make a good short course in physics. A particularly nice inclusion is the brief treatment of atomic structure and the origin of spectroscopic names for real energy levels in the LS coupling model. Many texts simply treat energy levels in the abstract and leave it to the student to decode the names of real levels in real lasers from some other book.

The next 100 pages cover gain, saturation, linewidth, threshold, three- and four-level laser alternatives, transient population inversion and pumping techniques. This is followed by 100 pages on Gaussian beams, optical resonators, Q-switching and mode locking. Next are 80 pages covering the characteristics of specific laser types, a much higher ratio of specific lasers to general theory than in any other text. Included are up-to-date descriptions of all commercially available gas lasers (helium–neon, argon ion, helium–cadmium, copper vapor, carbon dioxide, excimer and so on), dye lasers and solid-state lasers (ruby, Nd:YAG/glass, alexandrite, Ti:sapphire, Cr: LiSAF/LiCaF, fiber lasers and semiconductor lasers). The final 20 pages form a brief introduction to frequency conversion by nonlinear optical techniques.

Throughout *Laser Fundamentals,* the emphasis is on conveying a physical understanding of the processes and a sense of the numerical magnitude of the quantities involved. Silfvast is an excellent explainer. Examples set off in boxes are included in each section, giving calculations that demonstrate the numerical magnitude of a result. Other stylistic touches are the "boxing" of important equations and the repetition of the most important of these in the front and back flyleaves, the way a student would summarize before an open-book test. *Laser Fundamentals* is a good read, and I recommend it to students and their teachers alike.

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Vibrations and Waves

William Gough, John P. G. Richards and Rhys P. Williams
Prentice Hall, New York, 1996. 2nd edition. 249 pp. $38.00 pb ISBN 0-13-451113-1

In its second edition, William Gough, John P. G. Richards and Rhys P. Williams's *Vibrations and Waves*, first published in 1983, has been slightly reorganized and includes several new applications to current topics, as well as a companion diskette containing demonstration programs. The book is intended for an introductory course in vibrations, waves and optics, probably at the sophomore level. It has many strengths, but there are some counterbalancing weaknesses.

Some of the book's strong points are: the accompanying demonstration programs; a clearer-than-most generalization to waves in two and three dimensions; a nice introduction to the Dirac δ-function; and up-to-date and interesting applications, including nonlinear oscillations, optical fibers, piezoelectric vibrations, perception of sound, optical coherence and solitons. And the treatment of Fourier analysis is more complete than those of most other texts at this level.

Not all institutions require or even offer a course in vibrations, waves and optics, and among those that do there is far less uniformity of content than in general introductory first-year courses. It so happens that just two years ago my institution added such a course for the fall semester of the sophomore year, and I have been teaching it, so a key component of my assessment of *Vibrations and Waves* is its consonance with the design of the Haverford College course. (In choosing a text for our course I have recently examined the contents of most textbooks available for such a course. Space prevents inclusion of that useful information here, but interested instructors can find a table in my home