DEPARTMENTS

BOOK REVIEWS

Handbook of Lens Design

Daniel Malacara and Zacarias Malacara, Eds., xv + 649 pages, illus., subject index, references following each chapter, and three appendixes. Volume 44 in the Optical Engineering Series. ISBN 0-8247-9225-4. Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016 (1994) $125 hardbound.

Reviewed by John S. Loomis, University of Dayton, Ohio 45469-0151.

Finding good books about lens design is difficult because there are so few to choose from. There are dozens of books on image processing or fiber optics, but only a few about lens design. Thus an announcement about a new lens design book is a welcome event. The *Handbook of Lens Design* provides a comprehensive overview of geometrical optical design from the classical perspective.

Chapter 1 introduces general principles of geometrical optics. These include Fermat's Principle, refraction and reflection laws, exact meridional ray tracing methods, paraxial ray tracing, stops and pupils, the Optical Sine Theorem, and the Lagrange and Herschel optical invariance. Chapter 2 considers spherical and aspheric surfaces, exact skew ray tracing, and relations between ray and wave aberrations. Chapter 3 is a short chapter describing the properties of thin lenses and spherical mirrors. Chapter 4 discusses thick lenses and systems of several lenses. The concept of a stop shift is introduced, and the chapter ends with a discussion of the Delano diagram.

Chapters 5 through 8 cover the basic theory of aberrations. Chapter 5 discusses spherical aberration, including the thin lens, plane-parallel plate, and aspherical surfaces as examples. Other topics include surfaces without spherical aberration, higher orders of spherical aberration and aberration balancing, and caustic surfaces. Chapter 6 covers the off-axis monochromatic aberrations, including Petzval curvature, coma, astigmatism, and distortion. Chapter 7 reviews chromatic aberrations. The discussion starts with basic refractive index dispersion equations. Then the authors define axial chromatic aberration and discuss achromatic systems. Conrady's D-d method of achromatization, secondary color aberration, and the apochromatic triplet are also discussed. The final part of the chapter presents lateral chromatic aberration. Chapter 8 discusses the general aberration polynomial from the perspective of both wavefront and ray points of view. This chapter also introduces the topic of Zernike polynomials.

The next two chapters cover diffraction in optical systems and methods for computer evaluation of optical systems. Chapter 9 covers basic diffraction theory, resolution criteria, the Strehl ratio, optical transfer function, and Gaussian beams. At the end of the chapter we find ourselves approximately halfway through the book. Chapter 10 covers methods for computer evaluation of spot diagrams, wavefront deformation, point and line spread functions, and the optical transfer function.

Chapters 11 through 18 describe some of the main classical optical instruments and systems. Chapter 11 presents magnifiers, the landscape lens, single-mirror systems, periscopic lenses, and catadioptric systems. Chapter 12 covers complex photographic lenses (double gauss, triplet, tessar) and zoom lenses. Chapter 13 covers ophthalmic lenses. Chapter 14 surveys telescopes and afocal systems in general, and Chap. 15 pursues the subject of astronomical telescopes. Chapter 16 is about microscopes, and Chap. 17 is about projection systems. Chapter 18 covers prisms and systems of plane mirrors.

Chapter 19 is on optical design optimization and lens design programs. The chapter ends with a few paragraphs on modern trends in optical design, including global optimization and simulated annealing.

The *Handbook of Lens Design* is written in a very consistent style. The type is large enough to be easily readable. Many equations are boxed for emphasis. There are references at the end of each chapter and a general bibliography of lens design in Appendix 1. All of the figures appear to have been computer-generated and are plentiful, clear, and useful. However, the fonts used to generate labels and notation were vector fonts (rather than filled-outline fonts) and appear a little thin for my taste. Furthermore, the lines and curves have a distinct jagged appearance indicating a pixel-based output device with fairly low resolution. The tables have every row and column formatted with either single or double-line borders, which I find somewhat distracting.

The *Handbook of Lens Design* collects information about a large number of topics in lens design, and most readers should find at least some unfamiliar topics (ophthalmic lenses in my case). However, there are some missing topics that I would have included. For example, there is only one paragraph devoted to vignetting and no discussion of calculating vignetting (vignetting diagrams). Optical merit functions are defined, but are never really discussed. The discussion of higher order aberrations is more limited than I would have liked. Elliptical coma, for example, is never really described. There is no mention of the matrix approach to paraxial optics.

Mistakes and errors are to be expected in any book. One that caught my eye was the diagram representing the Sparrow resolution criteria, which should have a flat top rather than a dip at the Sparrow limit.

Although the *Handbook of Lens Design* makes an excellent reference book, I do not believe it would make a good textbook. There are no problems or worked examples. Many equations are given without derivation, and I believe that the order of topics should be different in a textbook than in a handbook.

Two recent books on lens design, *Lens Design* by Milton Laikin and *Modern Lens Design* by Warren J. Smith and Genesee Optics Software, Inc., are compendiums of case studies. The most recent new expository book on lens design is *Lens Design Fundamentals* by Rudolf Kingslake. The *Handbook of Lens Design* fits somewhere in-between. In retrospect, I would have liked to interchange the titles of Smith's book and the Malcaras' book. Anyone seriously interested in lens design will want a copy of the *Handbook of Lens Design*. Minor limitations aside, the book is an important contribution to the practice of optical engineering.

Fundamentals of Laser Optics

Kenichi Iga, 300 pages, illus., index, and references. ISBN 0-306-44604-9. Plenum Press, 233 Spring Street, New York, NY 10013 (1994) $49.50 hardbound.

Reviewed by Norman R. Goldblatt, Coherent, Incorporated, 5100 Patrick Henry Drive, Santa Clara, CA 95054.

Possibly owing to translation problems and a pedagogical style different than that found in the United States, the book does not deliver what was expected by this reviewer. The title, *Fundamentals of Laser Optics*, and the introduction promise to instruct the reader in those fundamentals necessary to utilize lasers and laser light in practical applications. In fact, the book, for the most part, is a very formal, scholarly treatise on laser theory.

The structure of the work is quite confusing. Specific details relevant to particular lasers and applications are inserted in an almost impulsive manner. Although not alluded to on the cover or in the introduction, the book is heavily biased toward semiconductor lasers at the expense of many other common laser types. Allusions to other types of lasers as well as their uses are often outdated. The number of glaring omissions is inexcusable. A table entitled the "History of Lasers" has, as its final entry, the development of the 1.3-μm GaInAsP laser in 1978!

Included are subjects that may not be treated in general laser optics texts. As an example, the chapter "Laser Resonators and Resonant Modes" includes distributed feedback and Bragg reflector configurations. However, there is no mention of unstable resonators. In point of fact, a table devoted to a summary of resonator types does not even mention this common configuration. There are no references to nonlinear optical processes as a method of generating other wavelengths. This is understandable considering the author's specialty in low-power devices. However, it reinforces the notion that the title of the book is misleading.

The text was obviously edited by a computerized spell checker. How else could you explain the consistent substitution of "local" for "focal" twice on a single page? The index is full of errors, with at least four found in a random check of one page. As with most word-processed works, the index cites the location of first occurrences regardless of context, further hobbling the reader's efforts at extracting useful information.

The illustrations consist of laser "clip art" interspersed with complex figures with little relevance to the text. Many contain too much information, requiring the reader to decide what pertains to the text and what just happened to be included. Each chapter concludes with a curious set of questions, most of which cannot be answered from material in the text.

The English-speaking editors of this book should have helped Dr. Iga find less idiosyncratic English terminology. As an example, laser applications are broken up into two broad categories, light optics and heavy optics!

The chapter devoted to laser beams certainly contains all the formalism necessary to calculate the complex beam parameters. However, the relationship between these parameters and practical beam characteristics is obscure. The only example given uses the elegant, if "old fashioned," Smith chart to calculate these parameters. The results are given in complex units of cavity length per meter squared! This is typical of the style in which these chapters were written.

Trying to develop a laser application from information in this book would be like attempting to launch a geosynchronous satellite after reading the 98-page masterpiece "Classical Mechanics" by Landau and Lifschitz. It's all there, it's elegant, but *now what?*

Obviously much work has gone into the preparation of this book—the next edition could be retitled *Semiconductor Lasers—Fundamentals, Fabrication, and Applications*. Possibly the chapters on basic resonator and propagation theory could be published under a separate title, and might stand alone as a tolerable text in a graduate physics curriculum. However, even here, much must be done to make the contents accessible to anyone other than those for whom mathematical formalism is an end in itself.