

DEPARTMENTS

BOOK REVIEWS

Modern Lens Design, A Resource Manual

Warren J. Smith and Genesee Optics Software, Inc., xi + 471 pp., illus., index. ISBN 0-07-05917804. McGraw-Hill, 1221 Avenue of the Americas, New York 10020 (1992) \$49.50 hardbound.

Reviewed by John S. Loomis, University of Dayton, Dayton, OH 45469-0140.

Modern lens design often consists of the selection of a starting lens form, transformation to the desired focal length, field of view, and $f/\#$, and finally optimization by an automatic lens design program. Compendiums of suitable design forms provide not only a selection of good starting points, but also insight into the final optical performance that may be expected from a given design form. The book *Modern Lens Design* is intended as an annotated resource of a large number of specific lens designs. It builds on a knowledge of geometrical optics and may be considered a companion volume to *Modern Optical Engineering* by Warren J. Smith.

The first chapter is a two-page introduction and overview that briefly reviews earlier books on lens design and places the current work in context. The second chapter is a guide to the use of lens design programs. Topics include merit functions, optimization, variables, and some common techniques for guiding the design process. The third chapter addresses design modification techniques that can be used to improve an existing design. These include splitting elements, changing glass types, balancing aberrations, and using symmetry. The fourth chapter, much shorter than the previous two, is a review of performance measures for optical systems. Chapter 5 is a general guide to lens design data, including some notes on the interpretation of ray intercept plots. The material in these first five chapters is narrative in style with only a few

mathematical equations and no mathematical exposition. A collection of common formulas used in lens design is given near the end of the book.

The lens designs in this book are presented in one-page figures consisting of three parts: the lens prescription, a drawing of the lens showing axial (marginal) and chief (principal) rays, and plots of the ray aberrations. The lenses are scaled to a common focal length of approximately 100, regardless of application. This simplifies the comparison of aberrations. The aberration plots include transverse ray errors for fans of three wavelengths for axial, 0.7 zonal, and full-field object points. Also included are

longitudinal aberrations, field curvature (sagittal and tangential), and distortion plots.

The central body of the book discusses a variety of design problems, as shown in the following table. The number of designs illustrated in each chapter is also provided in the table. The designs in this book, plus many others, have been incorporated into the *Warren J. Smith Lens Library*, a trademark of Genesee Optics Software, Inc.

The central chapters are dominated by lens design figures with a few pages of text. The discussions describe the basic design form, include historical perspective, and illustrate specific design techniques. These chapters are

Chapter/Title	Number of Designs
6 Telescope Objectives	17
7 Eyepieces and Magnifiers	29
8 Cooke Triplet Anastigmats	17
9 Reverse Telephoto Lenses	16
10 Telephoto Lenses	11
11 Double-Meniscus Anastigmats	10
12 The Tessar, Heliar, and Other Compounded Triplets	21
13 The Petzval Lens; Heads-Up Display Lenses	14
14 Split Triplets	15
15 Microscope Objectives	7
16 Mirror and Catadioptric Systems	20
17 The Biotar or Double-Gauss Lens	47
18 Wide-Angle Lenses with Negative Outer Elements	8
19 Projection TV Lenses and Macro Lenses	6
20 Zoom Lenses	18
21 Infrared Systems	15
22 Scanner/ $f - \theta$ and Laser Disk/Collimator Lenses	17
Total Designs	288

independent of one another and may be read in any order.

The last chapter, on the tolerancing of optical systems, gives some general guidelines on the principles of additive tolerances and establishing a tolerance budget.

This book is very similar in structure to *Lens Design* by Milton Laikin. Both provide lens prescriptions and drawings and discuss a large number of specific designs. The formats differ in that no aberration plots are included in Laikin's book. Instead, Laikin provides MTF data for a specific focal length and $f/\#$. One advantage of aberration plots is that linear aberration measures can be scaled. If all linear dimensions of a lens prescription are scaled by a constant factor, the focal length and linear aberrations are scaled by the same factor. The exact diffraction MTF cannot be scaled with the lens data because it includes diffraction effects that depend on wavelength (which is generally not scaled). Another advantage of aberration plots is that they generally contain more information about the order and magnitude of the residual aberrations. Since complete lens prescriptions are given in both books, the reader has the freedom to evaluate the lens designs according to individual taste. This freedom would be more easily exercised if there were a central repository of lens design data available (on Internet, for example), independent of specific software vendors.

This book follows the recent practice of including aperture data as part of the lens prescription. Specific glass names are given, as well as index and V numbers. The prescriptions would be more useful, however, if stop and pupil locations were made more explicit. The stop location is generally included in the lens prescription, but is not noted as such. The intended stop location can also be deduced from the zero-crossings of the chief ray in the lens drawing.

I counted the number of lens designs in the book, to verify the claims made on the back cover, and found that each zoom position of a zoom lens was counted as a separate design. Thus, the six zoom lenses discussed in the chapter on zoom lenses accounted for 18 different designs.

My major criticism of this book is the lack of organized references. There are some references, especially in the introduction, but they are included as part of the text. There are very few references given in the chapters on individual design problems. This is in contrast to the organization of Laikin's book, which has a much better collection of references.

Although this book and Laikin's book are both collections of optical designs, the overlap

in content is relatively small. Both books cover many of the basic lens design types, however *Modern Lens Design* provides a more complete general coverage and includes more examples. *Lens Design* has better coverage of specific applications, but *Modern Lens Design* discusses zoom lenses, a topic excluded from *Lens Design*. Clearly, both books are valuable contributions to the optical engineering community.

The combination of Warren J. Smith and Genesee Optics Software, Inc., presents an authoritative collection of lens design forms in a clear, readable format. *Modern Lens Design* is well worth acquiring by any student of the art of lens design.

Industrial Lasers and Their Applications

James T. Luxon and David E. Parker, 2nd ed., 305 pp., illus., index, bibliographies included in each chapter. ISBN 0-13-463803-4. Prentice-Hall, Professional and Technical Reference Division, Englewood Cliffs, NJ 07632 (1992) \$50 hardbound.

Reviewed by Jeffrey D. Hostetler, Pratt & Whitney, Division of United Technologies, 400 Main Street, Mail Stop 114-38, East Hartford, CT 06108.

This second edition of *Industrial Lasers and Their Applications* is a clear and logical evolution of its 1984 predecessor. It is intended to serve as a text for undergraduate engineering students and as an introduction to lasers and applications for practicing engineers and scientists becoming involved with industrial lasers. No background in optics is required; the needed fundamentals are included in the opening chapter.

About two-thirds of the book's material is devoted to treatment of the fundamental aspects of laser technology by the application of basic physics principles. This approach helps to demystify the subject while introducing the standard nomenclature of the field in a natural manner. Topics covered include basic laser theory, the unique properties of laser light, necessary conditions for laser action, properties of laser beams, and optical resonators.

On the applications side, excellent operational and theoretical descriptions are included for all of the commercial lasers currently used in industrial settings, including HeNe, Nd-YAG, carbon dioxide, diode, excimer, dye, and metal vapor devices. Applications discussed include measurement, alignment, and inspection processes employing low-power devices as well as

heat treating, welding, and metal removal operations involving higher power equipment. Laser interactions with both metals and non-metals are considered.

Throughout the book, analytical and theoretical foundations are included to allow the information presented to be extended into other areas of interest. Each chapter concludes with a problem set (no answers) and general references.

Instructors who have used the first edition in the past will probably not find themselves abandoned. The new edition includes a substantial amount of new material on low-power applications for alignment, gauging, inspection, interferometry, and holography. Most of the other changes involve relocating material to achieve a smoother logical flow. Several illustrations have been updated for improved clarity.

This seems like one of those books students will choose to keep at the end of the term for future reference, and they'll probably be glad they did.

BOOKS RECEIVED

Fiber Optic Communications, 3rd ed., by Joseph C. Palais. 340 pp., illus., index, bibliography. ISBN 0-13-473554-4. Prentice-Hall, Inc. (A Simon & Schuster Company), Englewood Cliffs, NJ 07632 (1992) \$51 hardbound. Covers fiber optic communications systems; optics review; lightwave fundamentals; integrated optic waveguides; optic fiber waveguides; light sources; light detectors; couplers and connectors; distribution networks and fiber components; modulation, noise, and detection; and system design.

Optical Computing: An Introduction, by Mohammad A. Karim and Abdul A. S. Awwal. 371 pp., illus., index, refs. ISBN 0-471-52886-2. John Wiley & Sons, Inc., 605 Third Avenue, New York 10158-0012 (1992) \$59.95 hardbound. Covers mathematical and digital image fundamentals, Fourier transform, basic diffraction theory, Fourier transform property of lenses, digital image fundamentals, image enhancement, image smoothing, differentiation, high-pass filtering, image restoration, analog optical computing, photographic film, spatial filtering using binary filters, inverse filtering, analog optical arithmetic, halftone processing, nonlinear optical processing, recognition using analog optical systems, joint transform correlation, phase-only filters, Mellin-transform-based correlation, number systems, logic elements and operations, combinational logic, sequential logic, digital optical computing, shadow-casting and symbolic substitution, and optical matrix processing.