DEPARTMENTS

BOOK REVIEWS

Lens Design

Milton Laikin, xvii + 326 pp. illus., index, references, Vol. 27 of the Marcel Dekker Series on Optical Engineering. ISBN 08-2478403-0. Marcel Dekker, Inc., New York (1990). $99.75 hardbound.

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

To understand the scope of this book, imagine expanding Chap. 13 of *Modern Optical Engineering* by Warren J. Smith (on the design of particular optical systems) into an entire volume. What Milton Laikin has produced for optical engineers is the equivalent of a source book of electronic circuits for electrical engineers.

The first chapter is a general discussion of lens design. Rather than an introduction to Snell's laws and raytracing, Laikin begins with merit functions and optimization methods. The first chapter assumes a general knowledge of geometrical optics and concentrates on the practical aspects of lens design. How many rays should you trace? When should you use aspherics? What wavelengths and spectral weights are appropriate for different spectral regions and applications? How should you choose glasses from a glass catalog? When do you add or subtract elements? What about thermal problems? How do you handle optical tolerances? What is expected in a lens drawing? How do you know when the design is good enough?

The next 31 chapters treat individual design problems. Chapters 2 through 6 cover basic lenses, the achromatic doublet, triplets, Petzval lenses, and the double Gauss. The next three chapters cover telephoto, inverted telephoto, and wide-angle lenses. The remaining 22 chapters cover a wide variety of optical systems: eyepieces, microscope objectives, afocal systems, relay optics, periscopes, catadioptric systems, endoscopes, enlarging lenses, projection lenses, telecentric systems, illumination systems, laser-focusing lenses, etc.

The chapters follow a standard format. They begin with a general discussion of the lens type or application and specific tips and suggestions on design procedures. This is followed by from one to five specific design examples. Each design example is accompanied by a table of lens parameters, a computer-generated drawing of the lens, and the polychromatic modulation transfer function (MTF) curve for an axial image and the sagittal and tangential MTF for an image at the edge of the field. References for additional information appear at the end of each chapter.

Some chapters are very short, for example, the chapter on Petzval lenses is five pages (one half page introduction, one page with two design tables, two pages of figures, and one half page of references). Other chapters are much longer, for example, 17 pages on catadioptric optical systems.

The lens data is given in a consistent format. Dimensions are in inches. The radius, thickness, diameter, and material for each lens surface are specified. Radii are given to four places past the decimal, thicknesses to three places, and diameters to two places. Materials are specified by glass name. The tables are ready to use in any lens design program with which I am familiar; Laikin lists commercial lens design programs in his last appendix. Several features of the tables pleased me greatly. First, the diameters (clear aperture) of each surface are given. These data are essential to producing a proper lens drawing, determining vignetting, and calculating changes in pupil location with field of view. None of the usual texts include diameter information. You have to deduce the dimensions from a lens drawing. Second, specific glass names are provided. All good lens design programs allow glass names to be used as input parameters. Laikin has four appendixes on indices of refraction of glasses for the visual region, UV region, mid-IR region, and long-IR region of the spectrum. These list the indices at specific wavelengths, the Abbé number, and partial dispersion for each glass. If your program does not handle a specific glass, you can use the data from these appendixes. Third, the position of the entrance pupil and back focal distance are given explicitly. There is no need to introduce paraxial solves or to guess at the stop location or best focal place. The tables explicitly locate them. Finally, the author routinely specifies the focal length, f/number, and field of view for each design. These are useful in a superficial reading of the text and as a cross-check when entering the data into a computer system.

I entered every design I could find into my own lens design format, and tried many of them with no problems or errors. I counted 82 different lens descriptions. This does not include the achromatic prism and wedge plate. By any count, the book contains numerous designs covering almost any standard design problem.

Laikin's data tables are commendable. This book should stand as a model for other authors on lens design. Nothing has frustrated me more than discussions of lens designs with lens drawings but no lens prescriptions allowing me to independently verify the information presented. Often an author chooses a set of ray fans or through-focus plots that I cannot relate to directly. With an accompanying data table I can evaluate the lens myself if I choose, then agree or disagree with the author's discussion. Although the MTF curves in Laikin's book are less informative than I would like, they are enough for preliminary study and I can get more detailed information about any of his designs.

Laikin's references are also worthy of commendation. As far as I am concerned, he covered all the bases. He references my favorite books on geometrical optics and lens design. The SPIE Proceedings and International Lens Design conferences are also represented. Most importantly, patent literature is covered. Each chapter concludes with a list of references on the specific design topic covered, and, as near as I can tell, the references are robust and timely.

In addition to the appendixes on refractive indices and commercial lens design programs, the book also includes appendixes on film formats, flange distances, and thermal-mechanical properties. Some of the information on refractive index and material properties can be found easily elsewhere; however, the information on film format and flange specifications has not been collected in any other book I have seen.

No book escapes an occasional typographical error or minor defect, and Laikin has a few. Some of the noncomputer-drawn figures, Figure 12-1, for example, could be better. In general, the reader should find the book easy to follow. Read the first chapter completely. Then read any other chapter as your interest leads.

Laikin does not cover every topic on lens design, but he clearly states his intentions in the preface (fixed conjugate, symmetric systems). I have no complaint with the overall content, except for wishing there were a chapter on Fourier transform lenses.

A few lens designers will find the material in this book common knowledge. For the rest of us, Laikin provides a wealth of design information and techniques. Even for the select few, Laikin has insights and information that may provide a fresh view on familiar problems. I found this book a comfortable fit to the optics library. It is a book that can be used routinely by students and professional practitioners of the art of lens design. If you are interested in classical optics and lens design, you will want to own a copy of Laikin's *Lens Design.*

BOOKS RECEIVED

Infrared Absorbing Dyes, edited by Masaru Matsuoka. 220 pp., illus., subject index, references. ISBN 0-306-434784. Plenum Press, 233 Spring Street, New York, NY 10013 (1990) $59.50 hardbound. Covers synthetic design of infrared absorbing dyes, cyanine dyes, quinone dyes, phthalocyanine and naphthalocyanine dyes, metal complex dyes, photochromic dyes, miscellaneous chromophores, semiconductor lasers, optical recording systems, thermal writing displays, laser printer applications, laser filter systems, infrared photography, and medical applications.

Fluoride Glass Fiber Optics, edited by Ishwar D. Aggarwal and Grant Lu. 401 pp., illus, subject index, references. ISBN 0-12-044505-0. Academic Press, 1250 Sixth Ave., San Diego, CA 92101 (1991) $69.95 hardbound. Covers fluoride glass composition and processing, fluoride glass structure, transparency of bulk halide glasses, purification and analysis of metal fluorides for use in heavy metal fluoride glasses, preform and fiber fabrication, optical fiber loss mechanisms, chemical durability of fluoride glasses, effects of high-energy radiation on halide glasses, and active phenomena in doped halide glasses.

The Hanle Effect on Level-Crossing Spectroscopy, edited by Giovanni Moruzzi and Franco Strumia. 371 pp., illus., subject index, references. ISBN 0-306-43630-2. Plenum Press, 233 Spring Street, New York, NY 10013 (1991) $89.50 hardbound. Covers a wide range of applications not only in the initial areas of atomic and molecular physics, but also in solid state physics, solar physics, laser physics, and gravitational metrology. Provides a complete physical insight into the Hanle effect and level-crossing spectroscopy, and presents an overview, as complete as possible, of their applications in many different fields of physics.

Handbook of Microwave and Optical Components, edited by Kai Chang. 484 pp., illus., subject index, references, ISBN 0-471-61365-7. John Wiley & Sons, Inc., 1 Wiley Dr., Somerset, NJ 08875-1271 (1991) $74.95 hardbound. Covers optical fiber transmission technology; optical channel waveguides and waveguide couplers; planar optical waveguides and waveguide lenses; optical modulation of electro-optical, acousto-optical, and magneto-optical devices; optical detectors; and liquid crystal materials, devices, and applications.

Materials Aspects of GaAs and InP Based Structures, edited by V. Swaminathan and A. T. Macrander. 606 pp., illus., subject index, references. ISBN 0-13-346826. Prentice Hall, Englewood Cliffs, NJ 07632 (1991). $60 hardbound. Covers crystal growth, x-ray structural characterization, electrical characterization, optical characterization, impurities and native defects, and defects and device properties.

Optical Fibres and Sources for Communications, edited by M. J. Adams and I. D. Henning. Part of the Updates in Applied Physics and Electrical Technology series. 182 pp., illus, subject index, appendix. ISBN 0-306-43711-2. Plenum Publishing Corp., 233 Spring St., New York, NY 10013 (1990). $49.50 hardbound. Covers propagation in multimode and monomode fibers, semiconductor luminescence, light-emitting diodes, semiconductor lasers, and selected abstracts on various topics.

Programming and Designing with the 68000 Family, edited by Tibet Mimar. 641 pp., illus., subject index, eight appendixes. ISBN 0-13-731498. Prentice Hall, Englewood Cliffs, NJ 07632 (1991) $59 hardbound. Includes a 68000 architecture overview; a family overview; programming the 68000 microprocessor; 68000 exception processing; 68010, 68012, and 68020 architectures and programming; coprocessor support; and hardware design for the 68000, 68010, and 68020.

Fiber Optics Communications, edited by Harold B. Killen. 233 pp., illus, subject index, references, appendixes. ISBN 0-13-313578-0. Prentice Hall, Englewood Cliffs, NJ 07632 (1991) $45 hardbound. Covers analog modulation, digital fiber optic system design, baseband coding for fiber optics, digital video transmission in optical fiber networks, optical receivers, coherent optical communications, and measurements in fiber telecommunications.