DEPARTMENTS

BOOK REVIEWS

Optoelectronics and Lightwave Technology

J. E. Midwinter and Y. L. Guo, 301 pages, illus., index, references. ISBN 0-471-92934-4. John Wiley & Sons Ltd., Baffins Lane, Chichester, West Sussex, PO19 1UD, England (1992) $64.95 hardbound.

Reviewed by A. Safaai-Jazi, Virginia Polytechnic Institute and State University, Bradley Department of Electrical Engineering, Blacksburg, VA 24061.

Technological advances in lightwave systems and components have been occurring at an astonishingly rapid pace during the past decade. While much of the information on recent developments in lightwave technology may be obtained from research papers and reports, there is a continuing need for a cohesive and systematic treatment of the material in this rapidly growing field. This book is a welcome addition to the list of texts covering advanced topics in optical fiber communications. It addresses issues in optoelectronics and lightwave technology in a concise and thorough manner with particular emphasis on recent developments in the field. The book deals with subsystems as well as devices in a self-contained style. It includes both theoretical analyses and experimental results, but more emphasis is laid on practical applications. The topics covered in this book would be of considerable interest to engineers, research scientists, students, and others working in this area.

The book consists of seven chapters. The introductory chapter provides background information on optical fiber communications and surveys important developments in optical fibers, guided-wave devices, semiconductor diode lasers, and advanced transmission techniques. The remaining six chapters are roughly divided into two parts, subsystems and components, with each part occupying three chapters. Chapter 2 addresses coherent lightwave tech-

nology. Principles of operation, modulation techniques, quantum limitations for various detection schemes, and polarization control are among the topics that are discussed in considerable detail. Wavelength-division multiplexing (WDM) and frequency-division multiplexing techniques are covered in Chap. 3. Several types of WDM devices are described and analyzed. Wavelength division photonic switching is also discussed at some length. An important section in this chapter is that on microwave subcarrier multiplexing, which has attracted considerable attention in recent years due to its potential applications in fiber optic analog multichannel video transmission. Optical time-division multiplexing and high-speed transmission techniques are dealt with in Chap. 4. This chapter updates the reader on the latest developments in ultra-high-speed fiber optic transmission systems. Of particular interest is the section on optical soliton transmission, which is currently an area of active research.

The last three chapters are devoted to optical fibers, semiconductor lasers, and guided-wave devices. Chapter 5 presents the electromagnetic theory of light propagation in optical fiber waveguides. Modal properties and dispersion characteristics of fibers are examined and attenuation mechanisms are discussed. Some components such as couplers, fiber amplifiers, and fiber lasers are briefly covered. Laser diodes and quantum well devices are treated in Chap. 6. There is a strong emphasis on distributed feedback and distributed Bragg reflector lasers. Multiple quantum well lasers and modulators also constitute important sections of this chapter. The final chapter addresses guided-wave optical devices. The coupled-mode analysis of parallel optical waveguides occupies a major portion of this chapter. The operation, analysis, and design of several devices including directional couplers, electro-optic switches, and modulators are discussed and fabrication methods are highlighted.

This book is a helpful reference for researchers and may also be used as a text for a graduate-level course in optical fiber communications. The exhaustive lists of references at the end of each chapter add to the strength of the book. The presentation of the material is clear. Individual chapters are well balanced and well organized. However, one should exercise caution in using this book as a stand-alone text for an undergraduate course aimed at beginning students. Previous exposure to the field is necessary in order to understand the material in this book.

There are important topics missing from the book. A separate chapter on photodetectors is conspicuously absent. The principles of operation of semiconductor light sources are not elaborated on. Also, problem sets are not provided at the ends of chapters, thus making the book less attractive as a textbook. There are also typographical errors in the text as well as in the equations. In Chap. 5, the authors neglected to number the equations.

Overall, the book accomplishes its stated goal and will prove to be a valuable addition to the library of those interested in optical fiber communications.

Applied Optics and Optical Engineering, Volume XI

Edited by R. R. Shannon and J. C. Wyant, 360 pages, illus., references. ISBN 0-12-408611-X. Academic Press, 1250 Sixth Avenue, San Diego, CA 92101 (1992) $110 hardbound.

Reviewed by Joseph M. Geary, Swales & Associates, 5050 Powder Mill Road, Beltsville, MD 20705.

Since the first volume of this series appeared in 1965, the editors have strived to provide readers with critical synopses of a wide range of topics in applied optics. This they have done superbly

in my opinion. The tradition started under Kingslake is ably continued under the stewardship of Bob Shannon and Jim Wyant, the current editors.

I am a fan of the series. Any reservations I had when initially asked to do this review were quickly dismissed when I was told I would receive a free copy. These books are a bit pricey. Volume II came into my possession while browsing through a used bookstore. It was like finding a nugget of gold. I would dearly love to have the complete set (which will only happen if left to me in someone's will!).

The contents of the present volume are as follows: Chap. 1, Basic Wavefront Aberration Theory for Optical Metrology, by Jim Wyant and Kathy Creath; Chap. 2, Fast Fourier Transforms and Their Applications, by John Hayes; Chap. 3, Optical Modeling, by George Lawrence; Chap. 4, Catalog of Spot Diagrams, by S. Zhang and Bob Shannon; Chap. 5, Principles of Optomechanical Design, by Daniel Vukobratovich; and Chap. 6, The Principles and Applications of Waveguide Gratings, by Laura Weller-Brophy.

Chapter 1 provides a practical introduction to aberration theory aimed at those engaged in optical interferometric metrology, i.e., those using Fizeau interferometers to test components or systems. The authors are well versed in this area. The text is concisely written and neatly illustrated. Aberrations are described in the exit pupil in terms of both Seidel and Zernike polynomials. A useful feature of the text is how the two coefficient types are related to each other. The Strehl ratio is discussed as well as its relationship to wavefront variance. The chapter closes with an excellent treatment of aspherics.

The chapter has some modest shortcomings. The two principal methods for acquiring aberration content from interferometric data, i.e., fringe following and phase measuring, should have been included and their relative merits discussed. Since interferometers cannot sense field curvature, distortion, or chromatic aberration (most operate at the HeNe wavelength), I thought that discussions on these subjects were a bit out of place. Finally, most aspherics cannot be tested without null optics as part of the interferometer setup. A brief discussion of their purpose and use would have been helpful in the latter sections.

Chapter 2 is an in-depth exposition on the ins and outs of the fast Fourier transform (FFT). It starts with a discussion of the discrete Fourier transform (DFT) and moves on to the Cooley-Tukey algorithm, the 1-D and 2-D FFT, and finally applications such as power spectrum, correlation, near- and far-field diffraction, and modulation transfer function. This is a chapter for computer jocks and those with a mathematical bent. Not my cup of tea. However, I have to admit to a morbid curiosity about the DFT. Hence I was grateful to the author for the section entitled "Graphical Development of the DFT." This section was a pictorial development including some math that gave me a good feel for what the DFT is all about. In the future, should I need to know about things such as leakage errors, decimation, signal flows, etc., I know where to look. The chapter is well illustrated and contains a number of DFT and FFT programs in BASIC.

Chapter 3 provides an extensive look at optical propagation (or diffraction) codes. These codes received considerable attention and development by the Air Force during the Airborne Laser Lab program. Dr. Lawrence has spent many years intimately associated with the high-energy laser (HEL) and beam propagation communities and is well qualified to present this topic. His well-illustrated chapter covers near- and far-field diffraction using both top-hat and Gaussian intensity distributions; propagation in homogeneous and nonhomogeneous media (including turbulence); and propagation in optical systems with particular attention to stable and unstable resonators.

The bottom line of most of this analysis is how it affects beam quality. Lawrence uses the Strehl ratio concept here, but in the HEL community beam quality is more commonly related to "power-in-the-bucket" or power within one Airy disk diameter. The chapter closes with a brief discussion of propagation codes such as the System Optical Quality or SOQ code and prominent features of modern codes.

Chapter 4 is a sequel and complement to an earlier presentation on diffractive imagery based on Zernike polynomials in Vol. X of this series. The present contribution again uses Zernikes, this time in a purely geometric context. The information is presented in two major formats: spot diagrams and MTF plots. The spot diagrams are not computed for a specific imaging system (as per a lens design code). Rather, they are determined via a Zernike polynomial description of the wavefront aberration in the exit pupil. Since rays are normal to the wavefront, once the latter is provided the former can be generated.

The first 37 Zernike polynomials are treated in turn. The common bond is that the rms wavefront for each term is 0.1 waves. No mixed aberrations are presented. Since the spot diagram appearance depends on the type of grid used in the entrance pupil, the authors provide four commonly used grids: rectilinear, hexapolar, circular, and random. The geometric MTF is computed only for the spot diagram based on the rectilinear grid. This MTF is obtained across three diameters oriented at 0, 45, and 90 deg.

Chapter 5 is a summary of the major considerations in optomechanics. As an optical scientist, I have grown to appreciate more and more the importance of good mechanical engineering design in supporting and holding optical components. I have found this insight to be particularly true when testing heavy optical components interferometrically, where the significance of proper mount design can be seen. Vukobratovich's chapter discusses the mounting of windows, prisms, lenses, and mirrors. He also treats thermal issues and athermalization methods. Numerous key equations are presented and discussed. No derivations are provided.

An optical engineer will have difficulty learning the fundamentals of optomechanical design from this chapter. It is by no means tutorial. A topic of this nature should be accompanied by a goodly number of illustrations. I was therefore greatly disappointed that no figures or graphs were included by the author. There are about 30 references, but a noticeable lapse is present. Paul Yoder's book entitled Opto-Mechanical Systems Design [Marcel Dekker, New York (1986)] is not mentioned.

Chapter 6 is a fascinating journey into the realm of integrated optics. All optical engineers are familiar with gratings as a means of dispersing light into its spectral contents. But the gratings discussed here are not in this vein. We are presented with an in-depth look at the importance and versatility of gratings as a means of controlling light within the context of planar waveguides. The text is well written and amply illustrated.

Waveguide gratings are set up as corrugations along the surface of a guide. They serve to couple light into and out of the guide. For example, chirped gratings (for which the spatial frequency changes along the guide interface) can focus light to an external line focus, and curved chirped gratings can focus to an external point focus. These gratings have important applications in optical disk heads. Waveguide gratings are also used to couple power between different guide modes having different mode number, polarization, and wavelength. They are also used to provide feedback in active guide layers for distributed feedback lasers.

The author provides two approaches to understanding waveguide grating behavior. The first is the traditional coupled-mode theory based on Maxwell's equations. The second is borrowed from multilayer thin-film analysis. It is a recursive technique developed by Rouard. The author shows how this procedure can be applied to waveguide gratings. The results are essentially the same as those obtained using the coupled-mode theory but they are obtained in a more intuitive manner.