DEPARTMENTS

BOOK REVIEWS

Integrated Optics: Design and Modeling

Reinhard Marz, 336 pages, illus., index, references, and four appendices. ISBN 0-89006-668-X. Artech House, 685 Canton Street, Norwood, MA 02062 (1995) $79.00 hardbound.

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My overall impression is that *Integrated Optics: Design and Modeling* will make a fine addition to almost anyone's collection of books on integrated optics. It will, however, serve its readers better as a reference book rather than as a text from which to first learn the basic concepts of integrated optics. I say this because the book is written at a fairly sophisticated technical level, though the author often moves rather quickly to the "bottom line" without providing material much beyond what is first necessary to introduce a problem or concept, and then a statement of the results and/or implications. It seems that the reader is assumed to have the necessary background in mathematics, quantum mechanics, and waveguide electromagnetics to fill in the blanks. An uninitiated reader will likely find this book both disappointing and frustrating. Nevertheless, *Integrated Optics* contains lots of useful and interesting information for the skilled engineer interested in designing and/or modeling integrated waveguide devices and structures.

On initially surveying the book, my first impression was that there are lots of nice figures and fairly current references. In all I counted 96 references, most of which were published within the past five to six years. After reviewing the book further, I developed the following impressions which I shall, for the most part, present on a chapter-by-chapter basis.

Chapter 1, of course, provides a general introduction to the history of integrated optics and to the book as a whole. The author also provides a discussion and nice comparison of common optical waveguide materials, though I feel his mathematical discussion of the evolution of the dielectric constant in InGaAsP is out of place and would find a better home in an appendix. On the other hand, I feel that the material in Appendix A, "Application of photonics," should have been included in the introduction. Enough said.

Chapter 2, "Foundations," provides a review of the basic electromagnetic principles needed for further study of integrated optics. Concepts such as the vector and scalar Helmholtz equations, polarization, dielectric boundary conditions, reflection and refraction at dielectric interfaces, and the eikonal and ray equations are presented. This chapter is included mostly for completeness and it's likely that most readers will skip this chapter initially and use it only for review when necessary. Anyone not already familiar with these concepts will find the rest of the book hopelessly confusing. As I've said this is not really a book for beginners.

Chapter 3, "Waveguide theory," though anything but an all-encompassing treatise on waveguide theory, presents several useful concepts relating to the theory of dielectric optical waveguides. For the most part, this chapter looks at various formulations and approximate solutions to the eigenvalue problem. I would have personally liked to have seen a more detailed physical discussion of modal field solutions in a few simple waveguiding structures (e.g., slab and rectangular waveguides), as well as a much more detailed discussion on dispersion. As it is, the author presents dispersion in only one page and offers only the results for material dispersion, with no discussion of dispersion compensation or control. On the other hand, probably the nicest parts of Chap. 3 are the author's discussions of geometric waveguide optics and the effective index method (a mathematical technique that provides approximate solutions to the eigenvalue problem for weakly guiding waveguides).

In my opinion, the real value of this book lies in the material covered in Chaps. 4 through 8. Chapter 4, "Beam propagation," develops in detail the beam propagation method as a means for numerically tracking the propagation of optical beams in complex waveguide structures (e.g., tapers), which may be difficult to describe quantitatively in closed form. Chapter 5, "Mode conversion," then discusses the efficient interfacing of optical waveguides. Specifically, butt coupling, imaging by optical systems, and adiabatic mode conversion via optical tapers are discussed in detail. Next, Chaps. 6 and 7, entitled "Codirectional coupling" and "Contradirectional coupling," respectively, though presented as separate chapters, are very complementary to one another. Both chapters develop nicely from the author's discussion of coupled mode theory presented in the early sections of Chap. 6. Though the author presents a fairly rigorous treatment of the underlying theory, the real focus of each of these chapters is on the descriptions of several integrated optical devices that rely on wave coupling. Of special interest, in my opinion, are the discussions of symmetric evanescent wave couplers, asymmetric coupler/filters, and Mach-Zehnder devices in Chap. 6, and in-line Bragg grating filters in Chap. 7.

The main text of the book then concludes with Chap. 8, "Planar spectrographs." This chapter takes a detailed look at focusing planar spectrographs, which are in essence diffracting elements having a fixed point of incidence. Such devices will find applications as multichannel filters for wavelength division multiplexing (WDM) optical com-

munication systems, for example. Frankly, this was a new topic of study for me and thus gave me the opportunity to evaluate the author's technical writing ability without already knowing what ought to be included. I'm happy to say that the sections of this chapter that I read in detail were presented clearly and at a level understandable by anyone already somewhat familiar with general waveguidance principles. Though I still feel that this is not suitable as a text book *per se*, I was indeed able to learn something new.

The author then rounds out his work with four appendices. As I mentioned earlier, you ought to read Appendix A, "Application of photonics," along with the introduction. Among other details, Appendix B, "Computer-aided engineering," includes the source code for several Matlab and Mathematica programs (I did not try them), which will likely help in paving the way for numerically simulating the concepts presented in the main text. I honestly did not read Appendix C, "Component cost modeling," though I'm sure it contains useful information for the practicing design engineer, and finally, Appendix D, "Mathematical background," provides a vector algebra review for those who want it and/or have trouble with the math in Chaps. 2 and 3.

In all this is a pretty good book. It does not provide a full treatment of integrated optical concepts and seems to assume at least some prior knowledge of guided wave optics. It does, however, contain a wealth of timely information for practicing optical design engineers wishing to further their knowledge of integrated optical devices. It will make a fine addition to my technical library. If I were to give this book a grade, I'd give it an A-.

Dr. Duncan would like to gratefully acknowledge the assistance of University of Dayton PhD student Robert J. Feldmann, whose comments have been incorporated into this review.

BOOKS RECEIVED

Advances in Integrated Optics, edited by Sergio Martellucci, Arthur N. Chester, and Mario Bertolotti. viii + 343 pp., illus., subject index, references following each chapter. Proceedings of the International School of Quantum Electronics 18th Course on Advances in Integrated Optics, held June 1–9, 1993, in Erice, Sicily. ISBN 0-306-44833-5. Plenum Press, 233 Spring Street, New York, NY 10013 (1994) $95.00 hardbound. The volume begins with two broad tutorial treatments by the course directors. Chapters 3 through 11 survey optical materials and processing techniques, covering not only nonlinear optical materials but also the growing use of semiconductors, glasses, and polymers. Chapters 12 through 16 describe a variety of integrated optics devices and their characteristics. Chapters 17 and 18 describe experiments with solitons and an improved technique for measuring waveguide losses. Finally, Chapters 19 through 23 describe systems applications of integrated optics.

Adapted Wavelet Analysis from Theory to Software, by Mladen Victor Wickerhauser. xii + 486 pp., illus., subject index, bibliography, exercises following each chapter. Three appendixes, including solutions to some of the exercises and a list of symbols. Program diskette to accompany book available for purchase through publisher. ISBN 1-56881-041-5. A. K. Peters, Ltd., 289 Linden Street, Wellesley, MA 02181 (1994) $59.95 hardbound. Beginning with an overview of the mathematical prerequisites, successive chapters rigorously examine the properties of the waveforms used in adapted wavelet analysis: discrete "fast" Fourier transforms, orthogonal and biorthogonal wavelets, wavelet packets, and localized trigonometric or lapped orthogonal functions. Other chapters discuss the "best basis" method, time-frequency analysis, and combinations of these algorithms useful for signal analysis, denoising, and compression.

Optical Engineering Fundamentals, by Bruce H. Walker. xv + 341 pp., illus., subject index, seven appendixes, summary following each chapter. From the Optical and Electro-Optical Engineering Series. ISBN 0-07-067930-4. McGraw Hill, Inc., 11 West 19th Street, New York, NY 10011 (1994) $40.00 hardbound. Includes details on thin lens theory; the nature of optical aberrations; the performance and limitations of optical components; basic optical instruments; optical materials and coatings used in modern systems; and the human visual system.

Handbook of Optics. Volume I: Fundamentals, Techniques, and Design. Volume II: Devices, Measurements, and Properties., edited by Michael Bass, Eric W. Van Stryland, David R. Williams, and William L. Wolfe. 2,600 pp., illus., subject index, list of contributors, glossary and fundamental constants for each volume, references following each chapter, glossary and introduction preceding most chapters. ISBN 0-07-047740-X (Volume I), 0-07-047974-7 (Volume II). McGraw Hill, Inc., 11 West 19th Street, New York, NY 10011 (1995) $99.50 per volume (hardbound). Volume I includes articles that cover: fundamental optics principles, including geometric, physical, and quantum optics; optical sources and detectors; detection and processing by human vision; design and fabrication, including optical layout techniques and lens design programs; optical thin film coatings; and optical properties of water and the atmosphere. Volume II includes articles that cover: elements, from the traditional to more recently developed components such as integrated, micro, binary, gradient index, fiber, and x-ray optics; instruments, from cameras to optical scanners to spectrometers; measurements, including theory and method; optical and physical properties of materials, including optical properties of semiconductors, polymeric optics, and photorefractive optics; and nonlinear optics.

Optoelectronics, by Endel Uiga. viii + 367 pp., illus., subject index, problems and recommended reading following each chapter, three appendixes, including solutions to problems. ISBN 0-02-422170-8. Prentice Hall, Inc., Simon & Schuster Education Group, 113 Sylvan Avenue, Englewood Cliffs, New Jersey 07632 (1995) $55.00 hardbound. Covers radiometry and photometry; elements of geometric optics; radiation sources; lasers; displays; radiation detectors; optical sensors and optocouplers; and principles of fiber optics.