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Book Reviews

Joseph L. Horner, Book Reviews Editor

Send books for review to the Managing Editor, Optical Engineering, P.O. Box 10, Bellingham, WA 98227-0010. Since there is not space to review all books received, the Book Reviews Editor will use his discretion in selecting those of most interest to the readership of this journal.

Electromagnetic Principles of Integrated Optics

Donald L. Lee, xv + 331 pp., illus., index, references. ISBN 0-471-87978-9. John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158 (1986) $39.95 hard-bound.

Reviewed by Leonard M. Johnson, Massachusetts Institute of Technology/Lincoln Laboratory, P.O. Box 73, Lexington, MA 02173.

Progress in the fields of integrated optics and fiber optics is continuing at a rapid pace. Recognizing this trend, the goal of the author is to provide an introductory textbook on time-harmonic electromagnetic theory, with an emphasis on optical rather than microwave technologies. The book is appropriate for an upper-level undergraduate or graduate course. Each chapter includes examples and problems. The book focuses on several areas of prime importance to integrated optics. These include dielectric waveguide analysis, coupled-mode theory, Bragg scattering, and prism coupling. There is very little coverage of active components such as electro-optic modulators and switches. The author assumes the reader has a working knowledge of vector calculus and is familiar with Maxwell's equations.

Chapters 1 and 2 provide introductory and review material. A brief historical introduction emphasizing optical communication leads into a short description of integrated optical devices. This is followed by a well-written review of basic electromagnetic theory, including Maxwell's equations, the wave equation, and plane-wave propagation in an isotropic medium. Other important review topics such as power flow and polarization are also covered.

The emphasis on optics begins in Chap. 3 with a discussion of plane-wave reflection and transmission at a dielectric interface. Topics covered include boundary conditions, Snell's law, reflection and transmission coefficients, and evanescent waves. The relationship between the phase shift on reflection and the Goos-Haenchen shift is treated as an advanced topic.

Chapters 4 and 5 are primarily concerned with waveguide analysis. Step-index slab waveguides are first described. A direct solution of the wave equation is presented along with a ray-tracing analysis. This is one of the best portions of the book in terms of providing physical insight of the mathematical results. The normalized waveguide dispersion diagrams are also given. The waveguide radiation modes are then analyzed by considering the limiting case of a dielectric slab waveguide with perfectly conducting mirrors placed a large distance away from the slab. This is an instructive approach but is flawed in this presentation by not discussing the issue of normalization. A single radiation mode extends to infinity and cannot be normalized; only a continuous spectrum of radiation modes can be physically realized. This is an important point that should be discussed to avoid confusion. Chapter 5 describes graded-index and three-dimensional waveguides. There are excellent discussions on the WKB and effective-index methods. There is also a section on radiation loss from curved waveguides.

Prism coupling is described in detail in Chap. 6. The analysis is based on a phasor representation that yields a particularly intuitive feel for the phase-matching requirement. Other important techniques for launching light into a waveguide such as grating coupling and endfire coupling are not described.

Chapter 7 covers several areas of waveguide fabrication. Waveguides in glass, semiconductors, and ferroelectrics are discussed. There is a good overview of fabrication techniques for several different types of optical waveguides. However, the emphasis on various topics is rather uneven. For example, there are nearly nine pages of discussion on semiconductor epitaxial growth but less than two pages on in-diffused guides in lithium niobate. An extensive list of references is provided.

The important topics of coupled-mode theory and Bragg scattering are covered in Chaps. 8 and 9. A basically mathematical derivation of the coupled-mode equations is presented and applied to a passive channel-waveguide directional coupler. The treatment of this topic is rigorous but is lacking with regard to physical interpretation. A discussion of coupled-mode theory in terms of induced polarization waves is not presented. This approach, which is used in many other texts and review articles, is very useful for gaining an intuitive understanding of mode coupling and particularly the phase-matching requirement. A discussion of the exact normal-mode treatment of directional couplers is also not included. The treatment of Bragg scattering is much better in terms of physical insight.

The final chapter of the book discusses optical fibers, emphasizing waveguiding properties of single-mode and multimode fibers. There is also a discussion of signal transmission along a fiber, with emphasis on the effects of modal dispersion.

Overall, this book presents a thorough treatment of several key areas of optical waveguide components. It should be of primary interest to those looking for background information in fiber and integrated optics. The book is concerned almost solely with passive waveguide components, and those interested in active components such as modulators and switches must therefore look elsewhere for information. As a textbook for an undergraduate electromagnetics course, this book is probably of limited value since many very important topics normally covered in such a course, such as resonators, antennas, and transmission line analysis, are not addressed. However, the book should be

useful for an elective or graduate-level course dealing primarily with guided-wave optics.

The Laser Guidebook

Jeff Hecht, x + 381 pp., illus., index, references. ISBN 0-07-027733-8. McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020 (1986) $49.50 hardbound.

Reviewed by Steve Feller, Coe College, Physics Department, Cedar Rapids, IA 52402.

The Laser Guidebook by Jeff Hecht is an excellent reference book on lasers. Anyone working with lasers will want to have this book on the bookshelf, ready to be used to look up technical information or to read a brief description on a particular topic. Indeed, this was the stated purpose of the author in writing the book—so that he might have it on his own bookshelf!

The text begins with several general chapters on such topics as "A Brief Laser History," "Laser Theory and Principles," and "Enhancements to Laser Operation." These chapters are very clearly written, although they would be somewhat terse to the newcomer to lasers. In addition, the material is at a level suitable for someone with quite a bit of technical background.

In my opinion, the science is uniformly correct, although here and there one could quibble about small points. For example, the author defines the index of refraction as being the ratio of the speed of light in vacuum to the speed of light in the material of interest and as having a value that "normally is greater than 1." For which cases is the index less than one? None that I know of!

The organization of the chapters is a strong point. They are clearly labeled and in a very orderly manner. Important parts of each chapter are highlighted, and they really are the important points!

The strongest and most important parts of the book are the numerous chapters on the various sorts of lasers in commercial and scientific use. These chapters are exceptional in the scope, clarity, and accuracy of information given; it is for these that one should buy the book. Fully 18 chapters are devoted to the different varieties of lasers available. These include the commonly encountered helium-neon, carbon dioxide, dye, and semiconductor diode lasers. However, these types are just the beginning in this book. Much useful information on each type of laser is included. Basic physics, construction of the laser, beam characteristics, prices, reliability and expected lifetimes, spectral characteristics, coherence lengths, modes of operation, safety (a welcome inclusion), operating conditions, options to the user, and applications are but a few of the topics covered.

Each chapter concludes with a good bibliography. All told, these bibliographies list several hundred sources; this, by itself, is quite an achievement for the book.

To be fair, the chapters on the different types of lasers do have some defects. Much repetition of basic ideas occurs throughout the chapters, but the newcomer to the topic will have some difficulty with the level of the discussion. The explanations tend to be short and to the point; this might be either a defect or an advantage, depending on the purpose and nature of the reader. And eventually, the reading does become tedious.

Appendix A of the book is a fine glossary of terms related to the use of lasers. After thinking for a while and still not being able to "fool" the glossary, I am of the opinion that it really is thorough and useful.

In summary, *The Laser Guidebook* is highly recommended to anyone interested in lasers. While it might be a difficult introduction to lasers, it is a great reference book on the subject.

Books Received

Laser Surface Treatment of Metals, Clifton W. Draper and Paolo Mazzoldi, eds. Proceedings of the NATO Advanced Study Institute on Laser Surface Treatment of Metals, San Miniato, Italy, Sept. 2–13, 1985. xix + 680 pp., illus., index, references. ISBN 90-247-3405-3 (1986). Nijhoff Publishers, P.O. Box 163, 3300 AD Dordrect, The Netherlands (U.S. distributor: Kluwer Academic Publishers, 101 Philip Drive, Assinippi Park, Norwell, MA 02061). Presents the latest developments in the science and technology of modifications of metallurgical surfaces due to laser treatment.

Tunable Solid State Lasers II, A. B. Budgor, L. Esterowitz, and L. G. DeShazer, eds. Proceedings of the OSA Topical Meeting, Rippling River Resort, Zigzag, Ore., June 4–6, 1986. Springer Series in Optical Sciences, Vol. 52, Arthur L. Schawlow, ed. xi + 368 pp., illus., references. ISBN 0-387-17320-X (1986). Springer-Verlag, 175 Fifth Ave., New York, NY 10010. Chapters on general spectroscopic methods, chromium spectroscopy, crystal growth, chromium tunable lasers, alexandrite lasers, titanium sapphire lasers, color-center lasers, neodymium and other rare-earth lasers, and applications and nonlinear optics.

Short Courses

SPIE Optical/Optoelectronic Engineering Update Series (Spring)

Engineering Update Series courses are designed to provide fundamental training in optics and optoelectronics to applied scientists, practicing engineers, and technical managers. This series will be held in conjunction with SPIE's 1987 Technical Symposium Southeast on Optics, Electro-Optics, and Sensors, 17–22 May, Peabody Orlando Hotel, Orlando, FL.

Electro-Optics Systems Engineering for Electrical Engineers, Ronald Cubalchini, Hughes Aircraft Co., Mon.–Tues., 9:00 am–6:00 pm.

Introduction to Fiber Optic Sensors, Michael Corke, Allied Amphenol Products, Sun.–Mon., 9:00 am–5:00 pm.

Introduction to Opto-Mechanical Design for Mechanical Engineers, Daniel Vukobratovich, Optical Sciences Ctr./Univ. of Arizona, Mon.–Tues., 9:00 am–6:00 pm.

Laser Radar, Richard J. Becherer, Science Applications International Corp.; Robert C. Harney, Martin Marietta Orlando Aerospace, Sun.–Mon., 9:00 am–5:00 pm.

Optical Phase Conjugation, Robert A. Fisher, RA Fisher Consulting, Thurs.–Fri., 9:00 am–6:00 pm.

Practical Radiometry, James M. Palmer, Optical Sciences Ctr./Univ. of Arizona, Mon., 8:30 am–6:30 pm; Tues., 8:30 am–1:00 pm.

SPIE 1987 Technical Symposium Southeast tutorial program, Orlando

The following tutorial program will be offered at SPIE's 1987 Technical Symposium Southeast on Optics, Electro-Optics, and Sensors, 17–22 May, Peabody Orlando Hotel, Orlando, FL.

Optics and Optical Systems

Advanced Techniques for Measurement and Interpretation of Optical Scatter, John C. Stover, Toomay, Mathis & Associates, Inc., Thurs., 6:00–10:00 pm.

Basic Optical Engineering, Glenn D. Boreman, Univ. of Central Florida, Sun., 8:30 am–5:00 pm.

Calibration and Standards for Laser Power and Energy Instrumentation, Aaron A. Sanders, National Bureau of Standards, Thurs., 8:30 am–12:30 pm.

Elements of Optical System Design, Robert E. Fischer, Ernst Leitz Canada Ltd., U.S. Operations, Sun., 8:30 am–5:00 pm.

Helmet-Mounted Displays, Richard A. Buchroeder, Optical Design Service, Thurs., 8:30 am–12:30 pm.