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# **Optical Waveguide Analysis**

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MASANORI KOSHIBA

# Optical Waveguide Analysis

**Robert G. Hunsperger**



## **Optical Waveguide Analysis:**

**Optical Waveguide Analysis** Masanori Koshiba, 1992 A solutions oriented introduction for electronic engineers and researchers to the computational tools used in the modeling and simulation of optical waveguides a critical technology in fiber optics communication and integrated optical electronics No index First published in Japanese in 1990 Annotation copyrighted by Book News Inc Portland OR     *Introduction to Optical Waveguide Analysis* Kenji Kawano, Tsutomu Kitoh, 2001-08-03 A complete survey of modern design and analysis techniques for optical waveguides This volume thoroughly details modern and widely accepted methods for designing the optical waveguides used in telecommunications systems It offers a straightforward presentation of the sophisticated techniques used in waveguide analysis and enables a quick grasp of modern numerical methods with easy mathematics The book is intended to guide the reader to a comprehensive understanding of optical waveguide analysis through self study This comprehensive presentation includes An extensive and exhaustive list of mathematical manipulations Detailed explanations of common design methods finite element method FEM finite difference method FDM beam propagation method BPM and finite difference time domain method FD TDM Explanations for numerical solutions of optical waveguide problems with sophisticated techniques used in modern computer aided design CAD software Solutions to Maxwell s equations and the Schrodinger equation The authors provide excellent self study material for practitioners researchers and students while also presenting detailed mathematical manipulations that can be easily understood by readers who are unfamiliar with them *Introduction to Optical Waveguide Analysis* presents modern design methods in a comprehensive and easy to understand format     *Optical Waveguides Analysis and Design* Amal Banerjee, 2022-03-09 This book offers readers a comprehensive detailed analysis and treatment of optical waveguides fiber slab an essential component of ultra high bandwidth long medium and short haul telecommunication The author describes an analysis scheme for optical waveguides that combines both geometric ray optics and Maxwell s equations based classical electrodynamics This unique approach enables readers to develop an intuitive understanding of this topic starting with macro properties e g V parameter of an optical fiber and progressively refining the analysis to individual modes of propagation through an optical waveguide An exhaustive set of diagrams highlight the key features of an optical waveguide property such as acceptance angle meridional and skew rays in an optical fiber or signal attenuation and dispersion in an optical waveguide The author also provides a set of ready to use ANSI C executables for both Linux and Windows that enable the reader to e g determine the allowed propagation modes even odd TE TM of a graded step index optical fiber and a slab waveguide Offers readers a single source reference to the analysis and design of optical waveguides Begins with macro level analysis of the properties of optical waveguides and dives deeply into details in a step by step manner enabling readers to develop an intuitive understanding Includes C language executables along with optical waveguide analysis and design examples to demonstrate their use in context     **Optical Fibre Waveguide Analysis**

Charles Tsao, 1992 A comprehensive but practical analysis methodology for treating optical fibre waveguides is presented in this book. It is designed for both college students and practicing scientists and engineers. The book presents a framework which treats the light waveguide as a continuum of polarizing devices to which a multitude of analysis techniques are applied. A more rigorous but easy to grasp mathematical arrangement is developed in Parts II and III for analyzing an all dielectric or metallic 1D or 2D optical structure. This basic technique is extended in Part IV to cover a general 2D or 3D curved optical fibre waveguide for which both the propagative and radiative far field distributions together with a set of characteristic equations and their solutions are established. Similar to these simplified straight or curvilinear guidance structures an elliptic waveguide or a fibre with the D shaped cladding may be characterized analytically but approximately as demonstrated in Part V. Also included in Part V is the so called finite element analysis as a distinctive alternative numerical computation method for analysing a more arbitrary fibre waveguide exhibiting an obvious irregularity or anisotropy.

**Microwave and Optical Waveguide Analysis by the Finite Element Method** F. Aníbal Fernández, Yilong Lu, 1996 This text presents a method which can be implemented on a personal computer for providing a complete description of the spectrum of microwave and optical waveguides including propagating evanescent and radiating modes. Full details of the mathematical formulation and its finite element implementation are given together with a variety of examples. It also provides ideas on how to solve sparse matrix eigenvalue problems more quickly and a number of state of the art examples in microwaves and optoelectronics.

*Optical Waveguide Analysis* Naoki Matsuda, 2005 Propagating Beam Analysis of Optical Waveguides Junji Yamauchi, 2003 This book is for graduate students and scientists interested in the numerical analysis of dielectric waveguides. Engineers in industries should be interested since optical waveguide analysis is becoming popular and indispensable in designing various optical devices at a small cost of time and labour. This text is a comprehensive introduction to a beam propagation analysis of optical waveguides and is the summary of the research investigations made at Hosei University Japan. The subject described in the book includes the finite difference beam propagation method BPM in Cartesian cylindrical and oblique coordinates. For the Cartesian coordinates based BPM semivectorial and fullvectorial BPMs are presented with some applications. Improved finite difference formulas are introduced to accurately analyze graded index and step index waveguides. The alternating direction implicit method is employed to efficiently treat three dimensional structures. To deal with a reflection problem a time domain BPM scalar FD TD method and vectorial FD TD method are provided. A hybrid technique that combines the BPM and the FD TD method is also described.

Optical Waveguide Theory by the Finite Element Method Masanori Koshihara, 1993 Recent advances in the field of guided wave optics such as fibre optics and integrated optics have included the introduction of various optical waveguides. Computational tools for modelling and simulation are essential for a successful design optimization and realization of the optical waveguides. Despite its relatively brief existence the finite element method has grown into a powerful and efficient tool for solving the most general optical

waveguide problems In this book starting with a brief review of electromagnetic theory for optical waveguide analysis the concepts of the finite element method and its fundamentals are discussed in detail Current topics of the application of the finite element method to various optical waveguide problems such as planar optical waveguides optical channel waveguides optical fibres polarization maintaining optical fibres optical gratings optical waveguide discontinuities nonlinear optical waveguides optical solitons and quantum well structures are described including many illustrations Optical Waveguides Maria L. Calvo, Vasudevan Lakshminarayanan, 2018-10-03 Although the theory and principles of optical waveguides have been established for more than a century the technologies have only been realized in recent decades Optical Waveguides From Theory to Applied Technologies combines the most relevant aspects of waveguide theory with the study of current detailed waveguiding technologies in particular photonic devices telecommunication applications and biomedical optics With self contained chapters written by well known specialists the book features both fundamentals and applications The first three chapters examine the theoretical foundations and bases of planar optical waveguides as well as critical optical properties such as birefringence and nonlinear optical phenomena The next several chapters focus on contemporary waveguiding technologies that include photonic devices and telecommunications The book concludes with discussions on additional technological applications including biomedical optical waveguides and the potential of neutron waveguides As optical waveguides play an increasing part in modern technology photonics will become to the 21st century what electronics were to the 20th century Offering both novel insights for experienced professionals and introductory material for novices this book facilitates a better understanding of the new information era the photonics century **Optical Waveguide Theory by the Finite Element Method** Masanori Koshiba, 2014-01-14 Recent advances in the field of guided wave optics such as fiber optics and integrated optics have included the introduction of arbitrarily shaped optical waveguides which in many cases also happened to be arbitrarily inhomogeneous dissipative anisotropic and or nonlinear Most of such cases of waveguide arbitrariness do not lend themselves to analytical solutions hence computational tools for modeling and simulation are essential for successful design optimization and realization of the optical waveguides For this purpose various numerical techniques have been developed In particular the finite element method FEM is a powerful and efficient tool for the most general i.e. arbitrarily shaped inhomogeneous dissipative anisotropic and nonlinear optical waveguide problem Its use in industry and research is extensive and indeed it could be said that without it many optical waveguide problems would be incapable of solution This book is intended for students engineers designers and technical managers interested in a detailed description of the FEM for optical waveguide analysis Starting from a brief review of electromagnetic theory the first chapter provides the concepts of the FEM and its fundamentals In addition to conventional elements i.e. line elements triangular elements tetrahedral elements ring elements and triangular ring elements which are utilized for one dimensional two dimensional three dimensional axisymmetric two dimensional and axisymmetric three dimensional problems respectively

special purpose elements such as isoparametric elements edge elements infinite elements and boundary elements are also introduced

**Fundamentals of Optical Waveguides** Katsunari Okamoto, 2010-08-04 Fundamentals of Optical Waveguides is an essential resource for any researcher professional or student involved in optics and communications engineering Any reader interested in designing or actively working with optical devices must have a firm grasp of the principles of lightwave propagation Katsunari Okamoto has presented this difficult technology clearly and concisely with several illustrations and equations Optical theory encompassed in this reference includes coupled mode theory nonlinear optical effects finite element method beam propagation method staircase concatenation method along with several central theorems and formulas Since the publication of the well received first edition of this book planar lightwave circuits and photonic crystal fibers have fully matured With this second edition the advances of these fibers along with other improvements on existing optical technologies are completely detailed This comprehensive volume enables readers to fully analyze design and simulate optical atmospheres Exceptional new chapter on Arrayed Waveguide Grating AWG In depth discussion of Photonic Crystal Fibers PCFs Thorough explanation of Multimode Interference Devices MMI Full coverage of polarization Mode Dispersion PMD

**Optical Waveguide Analysis Using Transmission Lines** Xin Qian, 2005

**Integrated Optics** Robert G. Hunsperger, 2009-04-29 Integrated Optics explains the subject of optoelectronic devices and their use in integrated optics and fiber optic systems The approach taken is to emphasize the physics of how devices work and how they can be and have been used in various applications as the field of optoelectronics has progressed from microphotronics to nanophotonics Illustrations and references from technical journals have been used to demonstrate the relevance of the theory to currently important topics in industry By reading this book scientists engineers students and engineering managers can obtain an overall view of the theory and the most recent technology in Integrated Optics

**Inhomogeneous Optical Waveguides** A. Ghatak, 2013-03-09 The propagation of electromagnetic waves in square law media i e media characterized by a quadratic spatial variation of the dielectric constant has been a favorite subject of investigation in electromagnetic theory However with the recent fabrication of glass fibers with a quadratic radial variation of the dielectric constant and the application of such fibers to optical imaging and communications this subject has also assumed practical importance Comparison of experimental results on propagation resolution and pulse distortion in such inhomogeneous waveguides with theory has put the field on a sound base and spurred further work The present book aims at presenting a unified view of important aspects of our knowledge of inhomogeneous optical waveguides A brief discussion of homogeneous dielectric waveguides is unavoidable since it forms a basis for the appreciation of inhomogeneous waveguides A short course based on some chapters of this book was offered to graduate students at IIT Delhi and was well received We consider that despite the unavoidable mathematical nature of the present book the comparison of experimental results with theory throughout and the description of fabrication technology Appen dixes A and B should make its appeal universal The authors are grateful to Dr K Thyagarajan for writing most of

Chapter 9 and to their colleagues Dr I C Goyal Dr B P Pal and Dr A Microwave And Optical Waveguide Analysis By The Finite Element Method F.A. Fernandez, **Optical Waveguide Theory** Yury Shestopalov, Yury Smirnov, Eugene Smolkin, 2022-03-26 This book addresses the most advanced to date mathematical approach and numerical methods in electromagnetic field theory and wave propagation It presents the application of developed methods and techniques to the analysis of waves in various guiding structures shielded and open metal dielectric waveguides of arbitrary cross section planar and circular waveguides filled with inhomogeneous dielectrics metamaterials chiral media anisotropic media and layered media with absorption It also looks into spectral properties of wave propagation for the waveguide families being considered and the relevant mathematical techniques such as spectral theory of non self adjoint operator valued functions are described including rigorous proofs of the existence of various types of waves Further numerical methods constructed on the basis of the presented mathematical approach and the results of numerical modeling for various structures are also described in depth The book is beneficial to a broad spectrum of readers ranging from pure and applied mathematicians in electromagnetic field theory to researchers and engineers who are familiar with mathematics Further it is also useful as a supplementary text for upper level undergraduate students interested in learning more advanced topics of mathematical methods in electromagnetics *An Introduction to Optical Waveguides* M. J. Adams, 1981 **Analysis of Optical Waveguide-ridge Waveguide** Mohamad Fadli Yusop, 2009 **Design and Analysis of Optical Waveguide Elements in Planar Geometry** Mirko Mirkov, 1998 Optical Waveguide Theory A.W. Snyder, J. Love, 1983-11-30 This is a comprehensive treatment of optical waveguide theory

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