



# Optical Waveguides Optical Waveguides

**Richard Black, Langis Gagnon**



## **Optical Waveguides Optical Waveguides:**

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 An Introduction to Optical Waveguides M. J. Adams, 1981 Advanced Materials for Integrated Optical Waveguides Xingcun Colin Tong Ph.D, 2013-10-17 This book provides a comprehensive introduction to integrated optical waveguides for information technology and data communications Integrated coverage ranges from advanced materials fabrication and characterization techniques to guidelines for design and simulation A concluding chapter offers perspectives on likely future trends and challenges The dramatic scaling down of feature sizes has driven exponential improvements in semiconductor productivity and performance in the past several decades However with the potential of gigascale integration size reduction is approaching a physical limitation due to the negative impact on resistance and inductance of metal interconnects with current copper trace based technology Integrated optics provides a potentially lower cost higher performance alternative to electronics in optical communication systems Optical interconnects in which light can be generated guided modulated amplified and detected can provide greater bandwidth lower power consumption decreased interconnect delays resistance to electromagnetic interference and reduced crosstalk when integrated into standard electronic circuits Integrated waveguide optics represents a truly multidisciplinary field of science and engineering with continued growth requiring new developments in modeling further advances in materials science and innovations in integration platforms In addition the processing and fabrication of these new devices must be optimized in conjunction with the development of accurate and precise characterization and testing methods Students and professionals in materials science and engineering will find Advanced Materials for Integrated Optical Waveguides to be an invaluable reference for meeting these research and development goals *Optical Waveguides* María 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

**Theory of Dielectric Optical Waveguides 2e** Paul Liao, 2012-12-02 Theory of Dielectric Optical Waveguides Second Edition focuses on the practical usage of optical waveguides This book explores the rapid growth of integrated optics which is devoted to the development of microscopic optical circuits based on thin film technology Organized into nine chapters this edition starts with an overview of the properties of dielectric slab waveguides This book then examines the theory of directional couplers with and without diffraction gratings Other chapters describe the numerical methods for solving guided mode as well as wave propagation problems This text discusses as well the beam propagation method and the popular effective refractive index method The final chapter deals with the significance of nonlinear phenomena This book is a valuable resource for undergraduate and graduate students of physics and electrical engineering Practicing engineers and scientists in the fields of integrated optics optical communications and fiber sensors will find this book extremely useful

**Planar Optical Waveguides and Fibres** Hans-Georg Unger, 1977 **Optics and Lasers** Matt Young, 2013-06-29 In this newest edition of Optics and Lasers I have added a substantial number of problems and moved most of the older ones to the end of the book There are now about one hundred problems which I hope will make the book more useful in the classroom As before some of the problems derive an especially important or useful result these I have left integrated within the body of the book In such cases I state the result and often give it an equation number and a citation in the index Teachers who adopt the book may obtain solutions to the problems by asking me for them on letterhead stationery In addition I have rewritten over a dozen paragraphs to improve their clarity or precision and further corrected minor errors of punctuation and taken care of other such small details The field of optics has been changing greatly for almost two dozen years Partly because of the applied or engineering nature of much of modern optics there has been a need for a practical text that surveys the entire field Such a book should not be a classical optics text but rather it should be strong on principles applications and instrumentation on lasers holography and coherent light and on optical fiber waveguides On

the other hand it should concern itself relatively little with such admittedly interesting phenomena as the formation of the rainbow or the precise determination of the speed of light

**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 Waveguides** N.J Cronin, 1995-01-01 A concise introduction to waveguides Microwave and Optical Waveguides presents the fundamental mathematical and physical principles that underpin the operation of waveguides The book provides a unified treatment of various waveguides as used in different wavelength regions throughout the spectrum It emphasizes the features common to each type without over emphasizing their differences Each chapter examines different types of waveguides from the most simple transmission lines to circular dielectric waveguides Chapters also include detailed examples and a set of problems The book contains references for further reading Assuming background knowledge of basic electromagnetic theory as well as some mathematical fundamentals Microwave and Optical Waveguides ensures that both students and engineers become familiar with the important concepts and techniques irrespective of the frequency band or terminology used for a particular waveguide

**Optical Waveguide Theory** A.W. Snyder, J. Love, 1983-11-30 This is a comprehensive treatment of optical waveguide theory

*An Introduction to Optical Waveguides* Michael J. Adams, 1981

**Optical Waveguide Modes: Polarization, Coupling and Symmetry** Richard Black, Langis Gagnon, 2010-02-17 A complete guide to optical waveguide modes This in depth work explains how transverse optical waveguide geometry influences field distribution and polarization properties You will gain a thorough understanding of the fundamental physics of mode structure Optical Waveguide Modes covers single and few mode optical waveguides with an emphasis on single core and multicore optical fibers and couplers including a large range of geometries and anisotropies Analysis is performed using extensions of the weak guidance perturbation formalism together with elementary group representation theory This definitive volume offers a detailed

introduction to and classification of diverse forms of fundamental and higher order modes and various polarization manifestations Coverage includes Electromagnetic theory for anisotropic media Weak guidance for longitudinally invariant fibers Circular isotropic longitudinally invariant fibers Azimuthal symmetry breaking Birefringence linear radial and circular Multicore and multifiber couplers

**Theory of Dielectric Optical Waveguides** Dietrich Marcuse, 1974-01-28 A textbook for graduate and undergraduate physics or electrical engineering students studying optical communications integrated optics and fiber sensors The material in the 1974 first edition is essentially unchanged new material includes information on coupled mode and coupled power theories approximate and numerical methods nonlinear effects and soliton propagation Annotation copyrighted by Book News Inc Portland OR

*Anisotropic and Nonlinear Optical Waveguides* C.G. Someda, G.I. Stegeman, 2012-12-02 Dielectric optical waveguides have been investigated for more than two decades In the last ten years they have had the unique position of being simultaneously the backbone of a very practical and fully developed technology as well as an extremely exciting area of basic forefront research Existing waveguides can be divided into two sets one consisting of waveguides which are already in practical use and the second of those which are still at the laboratory stage of their evolution This book is divided into two separate parts the first dealing with anisotropic waveguides and the second with nonlinear behaviour Nonlinear behaviour in optical waveguides is a topic of current research interest an effect eagerly being sought in waveguides The relative importance of nonlinearity versus anisotropy in theoretical papers changes enormously from problem to problem Many theories can be quite useful and enlightening even though they neglect entirely one of the two aspects Scientists may find their research work leading them in the near future to deal simultaneously with anisotropy and nonlinearity in order to pursue their own investigations This book will be of interest to researchers who first need to understand the individual topics suitably chosen from the two parts of this work thus providing them with the necessary ingredients to pursue their explorations

**Optical Waveguides** N Kapany, 2012-12-02 Optical Waveguides describes waveguide phenomena in classical optical terms This book discusses mode propagation by using equivalent plane waves polarization rays and intensity distributions Comprised of seven chapters this book starts with an overview of the history of optical waveguides with emphasis on the earliest studies of dielectric guides This text then explores the theoretical treatment of guided waves in planar dielectric waveguides in terms of the characteristic modes of these structures Other chapters consider the interferometric description of the coupling of a uniform beam of light into a thin film through the mechanism of frustrated total reflection This book discusses as well the properties of the modes of fiber optical waveguides The final chapter deals with the general properties of the characteristic TE wave modes of a symmetric slab guide by direct solution of the homogeneous Maxwell equations Students of optics and physics as well as electronic optical and communications engineers will find this book useful

**Optical Waveguide Theory by the Finite Element Method** Masanori Koshiya, 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 Waveguide Theory* Allan W. Snyder, John D. Love, 1991

**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 *Optical Waveguides and Devices Modeling and Visualization Using COMSOL Multiphysics Volume 2* Hee Lim, 2018-10-20 This pictorial manuscript is a step by step graphical illustrations for waveguides and devices modeling and computational physics simulation using COMSOL Multiphysics with Ray Optics Wave Optics and AC DC Electrostatics modules All the example models investigated and visualized with the help of Finite Element Analysis are referenced from the standard USA undergraduate text on Optical Guided Waves and Devices by Richard Syms and John Cozens The simulations include the use of geometrical ray tracings for point source and full electromagnetic waves source employing the Maxwell's wave equations for plane wave input Both 2D and 3D simulation results will help in visualize the electromagnetic field propagating inside the waveguides and devices Readers without fundamental handle on optics

modeling are suggested to read the Optics Modeling and Visualization with COMSOL Multiphysics A step by step graphical instruction manuscripts for detailed discussion These models may be expanded to post graduate research and industrial photonics waveguides and devices development There are 46 chapters of different 2D and 3D optical waveguides devices structures modeled and simulated in Volume 1 and 2 Volume 1 models include 3D single mode optical fiber planar waveguide channel waveguide longitudinal and transverse phase modulator surface plasmon optical square waveguide tapered waveguide FTIR beamsplitter in ray tracing and electromagnetic wave solvers full prism coupler halved prism coupler plano convex overlay lens overlay Luneburg lens geodesic lens with control setup for resulted electric field comparison corrugated gratings transmission and reflection gratings chirped grating lens beam expander grating grating coupler chirped grating coupler buried channel waveguide Volume 2 models continue with the ridge channel waveguide strip loaded channel waveguide GaAs GaAlAs planar waveguide GaAs GaAlAs heterostructure waveguide radiation leaks at fiber bend radiation leaks at waveguide bend c axis Calcite polarizer waveguide integrated optic normal reflector horn channel waveguide Y Junction waveguide optical phase modulator cut off modulator electro optic Mach Zehnder interferometer waveguide parallel coupling waveguide electro optic directional coupler single polished fiber directional coupler double polished fiber directional coupler tunable coupling strength of polished double fiber coupler cross sectional coaxial fiber coupler 2D directional coupler with tapered coupling corrugated reflection gratings optical fiber grating on half polished fiber coupler and track changing reflector with grating assisted coupling fiber

Optical Polymer Waveguides Jörg Franke, Ludger Overmeyer, Norbert Lindlein, Karlheinz Bock, Stefan Kaierle, Oliver Suttmann, Klaus-Jürgen Wolter, 2022-12-06 Light signals in optical waveguides can be used to transmit very large amounts of data quickly and largely without interference In the industrial and infrastructural sectors e g in the automotive and aerospace industries the demand to further exploit this potential is therefore increasing Which technologies can be used to effectively integrate systems that transmit data by means of light into existing components This is a central question for current research So far there have been some technical limitations in this regard For example it is difficult to couple the signal of an optical waveguide to other optical waveguides without interruption There is also a lack of suitable fabrication technologies for three dimensional waveguides as well as design and simulation environments for 3D opto MID This book addresses these and other challenges



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