

Matlab Code to Design A Slotted Waveguide Array Antenna

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Abstract

This article presents a MATLAB script used to design slotted waveguide array (SWA) antennas. A brief theory of the antenna is discussed to understand the scope and requirement of this code. A numerical comparison is also presented to design a SWA of 25 GHz to validate the proposed script.

I. INTRODUCTION

Slotted waveguide array antenna is known for its high power radiation and is often employed in space applications. It possesses a significantly high antenna gain by exploiting the radiations through multiple slots placed at half wavelength distances. The effects of slots on waveguide is thoroughly discussed in [1] which inspired the design of SWA as discussed in [2]–[4]. The slot placement on the waveguide plays a critical role to optimize the antenna radiation at a given frequency. In this article a MATLAB script is presented which is inspired by the analytical discussion presented in [3], [4]. A brief theory of SWA is discussed in Sec. II which is followed by the Matlab script in Sec. III, numerical validation in Sec. IV and conclusion in Sec. V.

II. THEORY

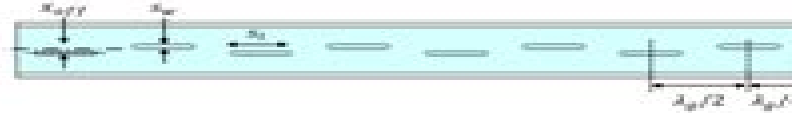


Fig. 1. Schematic of a SWA indicating the slot length s_l , slot width s_w and slot offset from the longitudinal axis x_{off} . λ_g is the guided wavelength at the operating frequency considering the waveguide dimensions.

Schematic of a conventional SWA is shown in Fig. 1. It consists of a rectangular waveguide terminated at one end with multiple slots on one of its broad wall. The slots are placed longitudinally in a tandem orientation by maintaining a distance of the multiple of the guided wavelength (λ_g). It increases the interaction of slots with the standing wave inside the terminated waveguide to increase the antenna radiation. The total radiated electric field ($E_r(\theta)$) can be approximated using array theory by considering the radiation from individual slots

$$E_r(\theta) = f(\theta) \sum_{n=1}^N \alpha_n e^{jnk \frac{\lambda_g}{2} \cos\theta} \quad (1)$$

where, $f(\theta)$ is the radiated electric field of a slot, α_n is the magnitude of excitation coefficient of the n th slot, k is the free space wave number at the operating frequency and θ is the angle of observation. Since the slot-field is a function its placement about the waveguide axis, the conductance of the n th slot can be calculated from the excitation coefficients as

$$g_n = \frac{\alpha_n^2}{\sum_{n=1}^{N/2} \alpha_n^2} \quad (2)$$

It can also be expressed in terms of the design parameters of the SWA as

$$g_n = 2.09 \frac{\lambda_g}{\lambda_0} \frac{a}{b} \cos^2\left(\frac{\pi \lambda_0}{2 \lambda_g}\right) \sin^2\left(\frac{\pi x_{off}}{a}\right) \quad (3)$$

where, a and b are the inner dimensions of the corresponding waveguide. These equations are used to design the SWAs at the operating frequency as will be explained in the following section.

Waveguide Dispersion Matlab Code

Clifford Pollock, Michal Lipson



Waveguide Dispersion Matlab Code:

Electromagnetic Propagation and Waveguides in Photonics and Microwave Engineering Patrick Steglich, 2020-10-21 Optical and microwave waveguides have attracted much research interest in both science and industry The number of potential applications for their use is growing rapidly This book examines recent advances in the broad field of waveguide technology It covers current progress and latest breakthroughs in emergent applications in photonics and microwave engineering The book includes ten contributions on recent developments in waveguide technologies including theory simulation and fabrication of novel waveguide concepts as well as reviews on recent advances **Computational Photonics** Marek S. Wartak, 2013-01-10 A comprehensive manual on the efficient modeling and analysis of photonic devices for graduate students and researchers in engineering and physics Guided Wave Photonics Le Nguyen Binh, 2016-04-19 A comprehensive presentation of the theory and simulation of optical waveguides and wave propagations in a guided environment Guided Wave Photonics Fundamentals and Applications with MATLAB supplies fundamental and advanced understanding of integrated optical devices that are currently employed in modern optical fiber communications systems and p *Optical and Wireless Technologies* Vijay Janyani, Manish Tiwari, Ghanshyam Singh, Paolo Minzioni, 2018-02-12 This book presents selected papers from 1st International Conference on Optical and Wireless Technologies providing insights into the analytical experimental and developmental aspects of systems techniques and devices in these spheres It explores the combined use of various optical and wireless technologies in next generation networking applications and discusses the latest developments in applications such as photonics high speed communication systems and networks visible light communication nanophotonics and wireless and multiple input multiple output MIMO systems The book will serve as a valuable reference resource for academics and researchers across the globe **Electromagnetic and Photonic Simulation for the Beginner: Finite-Difference Frequency-Domain in MATLAB®** Raymond C. Rumpf, 2022-01-31 This book teaches the finite difference frequency domain FDFD method from the simplest concepts to advanced three dimensional simulations It uses plain language and high quality graphics to help the complete beginner grasp all the concepts quickly and visually This single resource includes everything needed to simulate a wide variety of different electromagnetic and photonic devices The book is filled with helpful guidance and computational wisdom that will help the reader easily simulate their own devices and more easily learn and implement other methods in computational electromagnetics Special techniques in MATLAB are presented that will allow the reader to write their own FDFD programs Key concepts in electromagnetics are reviewed so the reader can fully understand the calculations happening in FDFD A powerful method for implementing the finite difference method is taught that will enable the reader to solve entirely new differential equations and sets of differential equations in mere minutes Separate chapters are included that describe how Maxwell's equations are approximated using finite differences and how outgoing waves can be absorbed using a perfectly matched layer absorbing

boundary With this background a chapter describes how to calculate guided modes in waveguides and transmission lines The effective index method is taught as way to model many three dimensional devices in just two dimensions Another chapter describes how to calculate photonic band diagrams and isofrequency contours to quickly estimate the properties of periodic structures like photonic crystals Next a chapter presents how to analyze diffraction gratings and calculate the power coupled into each diffraction order This book shows that many devices can be simulated in the context of a diffraction grating including guided mode resonance filters photonic crystals polarizers metamaterials frequency selective surfaces and metasurfaces Plane wave sources Gaussian beam sources and guided mode sources are all described in detail allowing devices to be simulated in multiple ways An optical integrated circuit is simulated using the effective index method to build a two dimensional model of the 3D device and then launch a guided mode source into the circuit A chapter is included to describe how the code can be modified to easily perform parameter sweeps such as plotting reflection and transmission as a function of frequency wavelength angle of incidence or a dimension of the device The last chapter is advanced and teaches FDFD for three dimensional devices composed of anisotropic materials It includes simulations of a crossed grating a doubly periodic guided mode resonance filter a frequency selective surface and an invisibility cloak The chapter also includes a parameter retrieval from a left handed metamaterial The book includes all the MATLAB codes and detailed explanations of all programs This will allow the reader to easily modify the codes to simulate their own ideas and devices The author has created a website where the MATLAB codes can be downloaded errata can be seen and other learning resources can be accessed This is an ideal book for both an undergraduate elective course as well as a graduate course in computational electromagnetics because it covers the background material so well and includes examples of many different types of devices that will be of interest to a very wide audience

Fundamentals of Electromagnetics with MATLAB Karl Erik Lonngren, Sava Vasilev Savov, Randy J. Jost, 2007 Accompanying CD ROM contains a MATLAB tutorial

Full Matlab Code for Synthesis and Optimization of Bragg Gratings Fethallah Karim, 2018-11-07 This book presents a theoretical description of fiber Bragg gratings focusing on channels densification and the tunability of Bragg filters It also includes a full Matlab code for the synthesis and optimization of several kinds of fiber Bragg gratings by using the directed tabu search the simulated annealing method and the genetic algorithm Physical and optical parameters of uniform chirped and sampled fiber Bragg gratings are then reconstructed with these algorithms

Silicon Photonics Design Lukas Chrostowski, Michael Hochberg, 2015-03-12 From design and simulation through to testing and fabrication this hands on introduction to silicon photonics engineering equips students with everything they need to begin creating foundry ready designs In depth discussion of real world issues and fabrication challenges ensures that students are fully equipped for careers in industry Step by step tutorials straightforward examples and illustrative source code fragments guide students through every aspect of the design process providing a practical framework for developing and refining key skills Offering industry ready expertise the text supports

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Photonic Crystals Igor A. Sukhoivanov,Igor V. Guryev,2009-09-21 The great interest in photonic crystals and their applications in the last 15 years is being expressed in the publishing of a large number of monographs collections textbooks and tutorials where existing knowledge concerning operation principles of photonic crystal devices and microstructured fibers their mathematical description well known and novel applications of such technologies in photonics and optical communications are presented They challenge authors of new books to cover the gaps still existing in the literature and highlight and popularize of already known material in a new and original manner

Author of this book believes that the next step towards wide application of

photonic crystals is the solution of many practical problems of design and computation of the specific photonic crystal based devices aimed at the specific technical application In order to make this step it is necessary to increase the number of practitioners who can solve such problems independently The aim of this book is to extend the group of researchers developers and students who could practically use the knowledge on the physics of photonic crystals together with the knowledge and skills of independent calculation of basic characteristics of photonic crystals and modeling of various elements of integrated circuits and optical communication systems created on the basis of photonic crystals The book is intended for qualified readers specialists in the field of optics and photonics students of higher courses master degree students and PhD students As an introduction to the subject the book contains the basics of wave optics and radiation propagation in simple guiding media such as planar waveguides and step index fibers

Integrated Photonics Clifford Pollock,Michal Lipson,2013-06-29 From the beginning Integrated Photonics introduces numerical techniques for studying non analytic structures Most chapters have numerical problems designed for solution using a computational program such as Matlab or Mathematica An entire chapter is devoted to one of the numeric simulation techniques being used in optoelectronic design the Beam Propagation Method and provides opportunity for students to explore some novel optical structures without too much effort Small pieces of code are supplied where appropriate to get the reader started on the numeric work Integrated Photonics is designed for the senior first year graduate student and requires a basic familiarity with electromagnetic waves and the ability to solve differential equations with boundary conditions

MATLAB-based Finite Element Programming in Electromagnetic Modeling Özlem Özgün,Mustafa Kuzuoğlu,2018-09-03 This book is a self contained programming oriented and learner centered book on finite element method FEM with special emphasis given to developing MATLAB programs for numerical modeling of electromagnetic boundary value problems It provides a deep understanding and intuition of FEM programming by means of

step by step MATLAB programs with detailed descriptions and eventually enabling the readers to modify adapt and apply the provided programs and formulations to develop FEM codes for similar problems through various exercises It starts with simple one dimensional static and time harmonic problems and extends the developed theory to more complex two or three dimensional problems It supplies sufficient theoretical background on the topic and it thoroughly covers all phases pre processing main body and post processing in FEM FEM formulations are obtained for boundary value problems governed by a partial differential equation that is expressed in terms of a generic unknown function and then these formulations are specialized to various electromagnetic applications together with a post processing phase Since the method is mostly described in a general context readers from other disciplines can also use this book and easily adapt the provided codes to their engineering problems After forming a solid background on the fundamentals of FEM by means of canonical problems readers are guided to more advanced applications of FEM in electromagnetics through a survey chapter at the end of the book Offers a self contained and easy to understand introduction to the theory and programming of finite element method Covers various applications in the field of static and time harmonic electromagnetics Includes one two and three dimensional finite element codes in MATLAB Enables readers to develop finite element programming skills through various MATLAB codes and exercises Promotes self directed learning skills and provides an effective instruction tool **Asymmetric Dual**

Core Waveguides Soloman Raju Thokala,2023-01-11 This book highlights the dynamical behavior of self similar waves in asymmetric dual core waveguides The proposed dual core waveguide consists of two closely spaced adjoining fibers in which one fiber is active and the other is passive Due to the linear coupling between them the dynamics of the wave propagating through the passive core can be controlled by manipulating the dynamics of the wave propagating in the active core The optimal pulse compression or amplification of these waves as the length of the fiber tends to infinity is presented The exact Mobius transform self similar solutions that propagate through these waveguides self similarly are subject to simple scaling rules The book includes experiments conducted to corroborate the analytical predictions *State-of-the-Art Laser*

Spectroscopy and its Applications : Volume II Yufei Ma,Qun Hao,Karol Krzempek,2023-02-09 *Optical Fiber*

Communications Systems Le Nguyen Binh,2011-06-08 Carefully structured to provide practical knowledge on fundamental issues Optical Fiber Communications Systems Theory and Practice with MATLAB and Simulink Models explores advanced modulation and transmission techniques of lightwave communication systems With coverage ranging from fundamental to modern aspects the text presents optical communic Computational Electromagnetics for RF and Microwave Engineering David B. Davidson,2010-10-28 This hands on introduction to computational electromagnetics CEM links theoretical coverage of the three key methods the FDTD MoM and FEM to open source MATLAB codes freely available online in 1D 2D and 3D together with many practical hints and tips gleaned from the author s 25 years of experience in the field Updated and extensively revised this second edition includes a new chapter on 1D FEM analysis and extended 3D treatments of the FDTD

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Binh,2014-12-01 Carefully structured to instill practical knowledge of fundamental issues Optical Fiber Communication Systems with MATLAB and Simulink Models describes the modeling of optically amplified fiber communications systems using MATLAB and Simulink This lecture based book focuses on concepts and interpretation mathematical procedures and engineering *Advances in VLSI, Communication, and Signal Processing* Debashis Dutta,Harath Kar,Chiranjeev

Kumar,Vijaya Bhaduria,2019-12-03 This book comprises select proceedings of the International Conference on VLSI Communication and Signal processing VCAS 2018 It looks at latest research findings in VLSI design and applications The book covers a wide range of topics in electronics and communication engineering especially in the area of microelectronics and VLSI design communication systems and networks and image and signal processing The contents of this book will be useful to researchers and professionals alike **Frontier Research and Innovation in Optoelectronics Technology and**

Industry Khaled Habib,Elfed Lewis,2018-11-15 This book provides an overview of research achievements by industry experts and academic scientists in the subject area of Optoelectronics Technology and Industry It covers a broad field ranging from Laser Technology and Applications Optical Communications Optoelectronic Devices and Integration Energy Harvesting to Medical and Biological Applications Authored by highly regarded researchers contributing a wealth of knowledge on Photonics and Optoelectronics this comprehensive collection of papers offers insight into innovative technologies recent advances and future trends needed to develop effective research and manage projects Researchers will benefit considerably when applying the technical information covered in this book *Optical Communications from a Fourier Perspective* Palle

Jeppesen,Bjarne Tromborg,2023-11-17 Optical Communications from a Fourier Perspective Fourier Theory and Optical Fiber Devices and Systems covers a broad range of subjects spanning Fourier theory and signal analysis over photonic components including time lenses in optical communication Some of the theory is more generally applicable beyond optical communication and is of relevance also for communications engineering The Fourier theory dimension of the book presents the relationship between Fourier series and Fourier integrals and also the related Laplace transform The book covers wave propagation in optical waveguides based on Maxwell equations and the nonlinear Schrödinger equation Various modulation formats are addressed along with coherent detection and required bandwidth Optical Fourier transform in the form of time lens is covered for example in modulation format conversion and spectrum magnification and couplers and their use for optical discrete Fourier transformation are also discussed Other important subjects such as noise linewidth and coherence

are discussed in relation to semiconductor lasers Detailed derivations and a deeper background for the chapters are provided in appendices where appropriate Introduces Fourier theory and signal analysis tailored to applications in optical communications devices and systems Provides a strong theoretical background and a ready resource for researchers and advanced students in optical communication and optical signal processing Starts from basic theory and then develops descriptions of useful applications

Nano/Microscale Heat Transfer Zhuomin M. Zhang, 2020-06-23 This substantially updated and augmented second edition adds over 200 pages of text covering and an array of newer developments in nanoscale thermal transport In Nano Microscale Heat Transfer 2nd edition Dr Zhang expands his classroom proven text to incorporate thermal conductivity spectroscopy time domain and frequency domain thermoreflectance techniques quantum size effect on specific heat coherent phonon minimum thermal conductivity interface thermal conductance thermal interface materials 2D sheet materials and their unique thermal properties soft materials first principles simulation hyperbolic metamaterials magnetic polaritons and new near field radiation experiments and numerical simulations Informed by over 12 years use the author s research experience and feedback from teaching faculty the book has been reorganized in many sections and enriched with more examples and homework problems Solutions for selected problems are also available to qualified faculty via a password protected website Substantially updates and augments the widely adopted original edition adding over 200 pages and many new illustrations Incorporates student and faculty feedback from a decade of classroom use Elucidates concepts explained with many examples and illustrations Supports student application of theory with 300 homework problems Maximizes reader understanding of micro nanoscale thermophysical properties and processes and how to apply them to thermal science and engineering Features MATLAB codes for working with size and temperature effects on thermal conductivity specific heat of nanostructures thin film optics RCWA and near field radiation

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Table of Contents Waveguide Dispersion Matlab Code

1. Understanding the eBook Waveguide Dispersion Matlab Code
 - The Rise of Digital Reading Waveguide Dispersion Matlab Code
 - Advantages of eBooks Over Traditional Books
2. Identifying Waveguide Dispersion Matlab Code
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Waveguide Dispersion Matlab Code
 - User-Friendly Interface
4. Exploring eBook Recommendations from Waveguide Dispersion Matlab Code
 - Personalized Recommendations
 - Waveguide Dispersion Matlab Code User Reviews and Ratings
 - Waveguide Dispersion Matlab Code and Bestseller Lists
5. Accessing Waveguide Dispersion Matlab Code Free and Paid eBooks

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- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Waveguide Dispersion Matlab Code
 - Highlighting and Note-Taking Waveguide Dispersion Matlab Code
 - Interactive Elements Waveguide Dispersion Matlab Code
- 8. Staying Engaged with Waveguide Dispersion Matlab Code
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Waveguide Dispersion Matlab Code
- 9. Balancing eBooks and Physical Books Waveguide Dispersion Matlab Code
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Waveguide Dispersion Matlab Code
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Waveguide Dispersion Matlab Code
 - Setting Reading Goals Waveguide Dispersion Matlab Code
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Waveguide Dispersion Matlab Code
 - Fact-Checking eBook Content of Waveguide Dispersion Matlab Code
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development

- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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