AIP Conference Proceedings

64

H Index

Country United States - SIR Ranking of United States

Subject Area and Category Physics and Astronomy
Physics and Astronomy (miscellaneous)

Publisher American Institute of Physics

Publication type Conferences and Proceedings

ISSN 0094243X, 15517616

Coverage 1974-1978, 1983-1984, 1993, 2000-2001, 2003-2020

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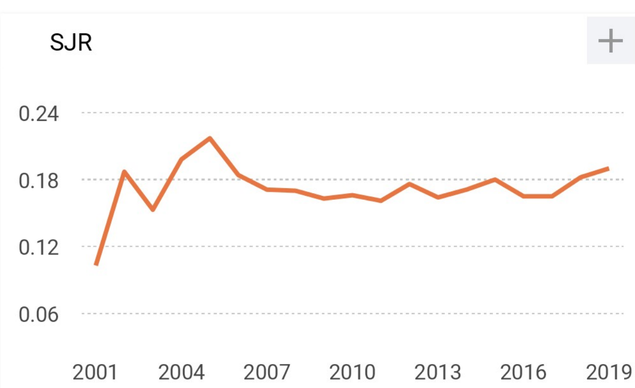

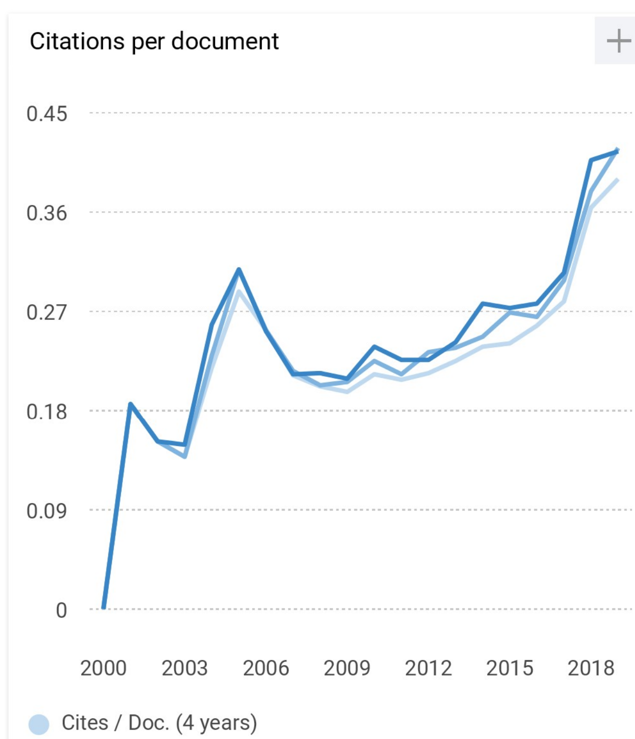

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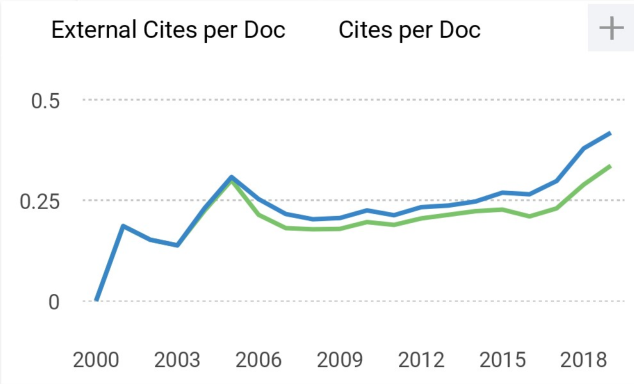

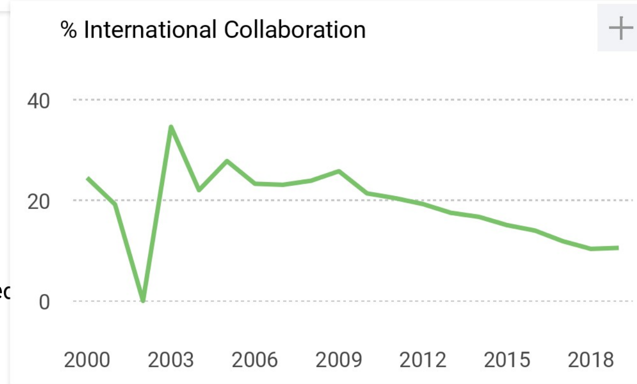

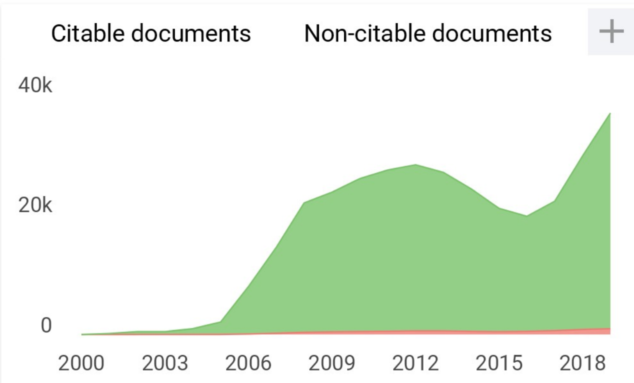

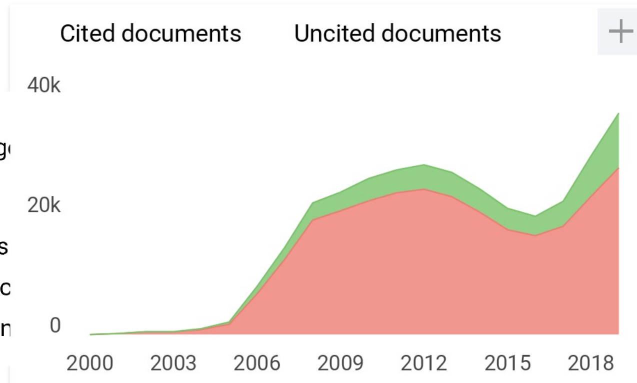

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Volume 2043

Conference collection

The 6th International Conference on Science & Engineering in Mathematics, Chemistry and Physics

ScieTech18: The Nature Math - The Science

Jakarta, Indonesia
20–21 January 2018

Editors
Ford Lumban Gaol, P. N. Gajjar and Jamil Akhtar

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Preface: 6th International Conference on Science & Engineering in Mathematics, Chemistry and Physics 2018

On behalf of the ScieTech18 Program Committee we feel pleasure to inform that the 6th International Conference on Science & Engineering in Mathematics, Chemistry and Physics 2018 (ScieTech18), which already held at the Arya Duta Hotel, Tugu Tani, Jakarta - Indonesia during 20 - 21 January 2018. The ScieTech18 was conjunction with The NatureMath and The Science. The proceedings of ScieTech18 were published in AIP conference series.

The ScieTech18 conference is aimed to bring together scholars, leading researchers and experts from diverse backgrounds and applications areas. Special emphasis is placed on promoting interaction between the theoretical, experimental, and applied communities, so that a high level exchange in new and emerging areas within Mathematics, Chemistry and Physics, all areas of sciences and applied mathematics is achieved.

The conference has so far been an important event and has attracted many scientists, engineers and researchers from academia, government laboratories, and industry internationally.

The scope of the ScieTech18 are Applied Mathematics & Statistics, Mathematics & Modeling, Mathematics Analysis & Its Applications, Algebra & Its Applications, Geometry & Its Applications, Algebraic Statistics & Its Applications, General Physics, Optical, Quantum Computing, Materials Science & Engineering, Chemical, Environmental, and Process Engineering, and Chemistry and Advances Chemical Engineering.

ScieTech18 keynote talk was delivered by eminent Industrial Scientist Prof. P. N. Gajjar from Department of Physics, Electronics & Space Sciences, University School of Sciences, Gujarat University, Ahmedabad 380 009, Gujarat, India. He delivered the talk in the title of: Engineering Thermal Devices: Simulation experiments. In his talk, Prof Gajjar mentioned with the progress in developing devices based electronics, spintronics, and photonics. The progresses to design and develop the devices that can utilize the flow of phonons are still rare. If flow of heat in solids could be controlled as electric current in semiconductor circuits, very large numbers of innovations could happen in thermal engineering.

The next keynote talk delivered by Prof Kiyota Hashimoto from Prince of Songkla University, Phuket Campus, Thailand. He delivered the keynote talk in the areas of IoT and a small step for social efficiency. In his talk, Prof Kiyota stated that IoT (Internet of Things), Big Data, and AI (Artificial Intelligence) are the top three buzz words in ICT research areas, and indeed a variety of applications have been realized in advanced parts of the world, both in and among countries. On the other hand, many other parts of the world still suffer from inefficiency issues at least some of which should be improved by technologies. In this talk, instead of summarizing the mainstream of IoT research, Prof Kiyota discussed an issue related to human flows as an example of small steps for social efficiency. Human flow is human behavior of movement and it has been already tackled both in research and commercial perspectives, but still we have inefficient building and event structure where a vast number of people makes inefficient move

The 6th International Conference on Science & Engineering in Mathematics, Chemistry and Physics
AIP Conf. Proc. 2043, 010001-1–010001-2; https://doi.org/10.1063/1.5080019
Published by AIP Publishing. 978-0-7354-1769-4/$30.00

and congestion as a reality. He introduced a recent research to analyze such human flow, and discuss what we can.

The last keynote talk was delivered by Prof. Fonny Dameaty Hutagalung from Department of Educational Psychology and Counseling, Faculty of Education, University Malaya, Malaysia. Her keynote talk title was Understanding the Relationship between Socioeconomic Status and Cognitive Abilities of Preschoolers. She mentioned on her talk that Preschool education has been gaining importance in many countries. Previous studies have explored the association between socioeconomic status (SES) and children cognitive abilities and found that parents that were involved in their children's education would influence their children's cognitive ability. Parents that are more involved in children's education do contribute to children's high levels of cognitive abilities. Her research results showed that 41% of the preschoolers have a moderate GCI score but they scored highly in the Quantitative section. The study also found that there was a significant difference in the father's education and the children's cognitive abilities. However, no significant differences were found on the other three variables including father's income, father's occupation and mother's education. This study concluded that parents with a low level of education does not necessarily have children with low cognitive abilities. There is a need to explore other variables that would impact children's level of cognitive abilities.

There were in all more than 71 full paper submissions which were peer examined and 21 were accepted for oral and poster presentation. The presentations were splits with the following theme 1. Mathematical Modelling, 2. Electronics, Communication and WSN, 3. Nano Technology and 4. Energy Conversion. Technical sessions were also with Exhibits of Industries. Participants eight countries made the conference international in scope.

As editors of ScieTech18 Proceedings, we have many people to thank and would like to put the appreciation of their contribution on record. While Keynote speakers and Invited speakers, Track Chairs, Session chairs and our technical reviewers are foremost in the list of people to be thanked. Last but not the least, our sincere appreciation and thanks to AIP Proceedings Series Editors especially to Ruth Levins with her relentlessly support to make sure the Proceedings published in good quality and timely manner.

Thank you.

Editors
Ford Lumban Gaol, Bina Nusantara University, Jakarta, Indonesia
Jamil Akhtar, CSIR-CEERI, Pilani, India
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The Method of Lines Analysis of Asymmetric Optical Waveguides

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Abstract. The starting point of any optical waveguide analysis is normally either Maxwell's equations or the vector wave equation. Usually very few exact analytical solutions can be obtained due to the complexity of these equations, which typically involve coupling of the three scalar components of both the electric and the magnetic field vectors. However, The slight variation in index is most helpful as it permits the vector wave equation to be replaced by a scalar equation in which the electric field is represented by one vector component. To solve such wave equation for the asymmetric optical waveguide structure, a numerical model based on the method of lines has been developed. A suitable form of the method of lines is presented in Cartesian coordinate, and absorbing boundary conditions based on the third-order rational series approximation are derived. A comparison with exact solution is also presented. It is found that the method of lines can be used as good approximation for an optical waveguide simulation.

1. INTRODUCTION

The technological advancement in optical devices processing technique has made the design and manufacture of various optoelectronics and optical devices systems becomes possible. In order to improve the design process, a number of numerical tools to simulate guided wave problems were developed. Up to the mid-seventies the numerical tools mainly concern with the modal solution of guided and radiated mode and in their respective cross-sections.

In 1976, Fleck, Morris and Feit proposed a method to analyze a free space laser beam propagation through the atmosphere using a parabolic approximation to the wave equation[1]. The solution was achieved with the help of fast Fourier transforms and was called the beam propagation method (FFT-BPM). Following this approach a number of new algorithm based on BPM is established. Chung and Dagli in 1990 introduced a finite difference method to solve the paraxial approximation and was called the finite difference beam propagation method (FDM-BPM)[2]. Furthermore, a number of authors have developed numerical algorithms and approximations, concentrating on quasi-vectorial solutions of the Helmholtz equation.

Among the techniques, one that offers a solution for a wide angles of beam divergence, taking scattering in consideration is the method of lines (MoL). This method has been shown to be a powerful method for the analysis of optical waveguides[3]. The wave equations are discretized in the transfer direction and solved analytically in the longitudinal direction. The MoL has always been an eigenmode algorithm and therefore reflected waves and radiation losses can be taken into account. In this paper an analysis of asymmetric optical waveguide will be presented, a comparison between an exact solution with those of MoL will be given.

The 6th International Conference on Science & Engineering in Mathematics, Chemistry and Physics
AIP Conf. Proc. 2043, 020018-1–020018-5; https://doi.org/10.1063/1.5080037
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2. THE METHOD OF LINES

To perform the analysis, it is necessary that the waveguide should be enclosed in a box with electric or magnetic walls. For the analysis of asymmetric optical waveguide as shown in Figure 1, we start by assuming that the guide is weakly guiding.

In addition, the medium is considered to be an isotropic, lossless medium. The general form of TE-polarized optical wave with harmonic variation $e^{j\omega t}$ and a z dependence of $e^{-j\beta z}$ for the wave propagation must fulfill the Helmholtz equation which is described by:

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial z^2} + k_o n^2(x)\psi = 0 \tag{1}$$

Where $\psi(x,z)=E_y(x,z)$ is the electric field, k_o is the free space wave number and $n(x)$ is the refractive index distributions.

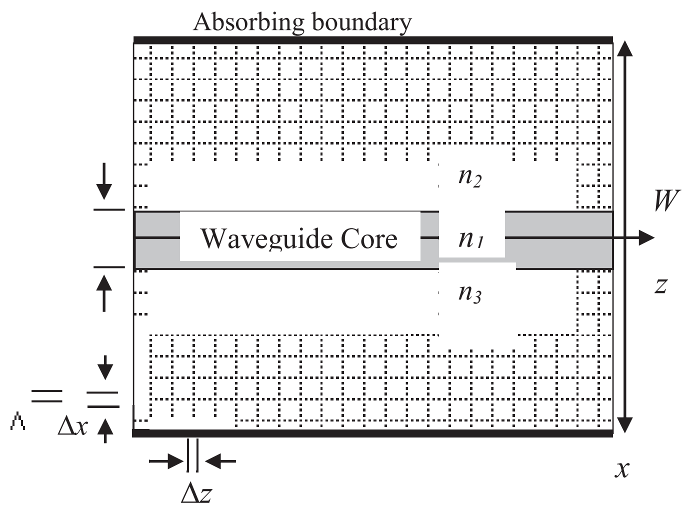

Figure 1. Discretisation used in the method of lines for Cartesian coordinates

The solution of Equation (1) by the method of lines is achieved by dividing the region in analysis in x-direction into infinite m discrete intervals of Δx. If this is done, we obtain a matrix-vector differential equation[4]:

$$\frac{\partial^2 \vec{\psi}}{\partial z^2} + \vec{Q}^2 \vec{\psi} = 0 \tag{2}$$

Here $\vec{\psi}$ is a vector of size m containing values of E at each line, $\vec{Q}^2$ is an mxm tridiagonal matrix containing the discretized form of the second derivative plus an mxm matrix containing diagonal elements of dielectric constant distribution n_N of the waveguide at the point of $x_1, x_2, \ldots, x_N$. Solutions for constant $\vec{Q}^2$ then have the form:

$$\overline{\psi}(z) = \overline{T}\exp(-j\overline{\beta}z)\overline{T}^{-1}\overline{\psi}_f + \overline{T}\exp(+j\overline{\beta}z)\overline{T}^{-1}\overline{\psi}_b \tag{3}$$

Where $\overline{\beta}$ and $\overline{T}$ are the eigenvalue and eigenvector matrices of $\vec{Q}$, respectively, so that $\overline{Q} = \overline{T}\overline{\beta}\overline{T}^{-1}$. Equation (3) contains both forward and backward waves, with amplitudes defined by $\overline{\psi}_f$ and $\overline{\psi}_b$. Backward waves may normally be neglected in a very long and weakly guiding structures. Generally n_r is a function of z, so the matrix $\vec{Q}$ may also vary. However (3) may still give a solution over a short distance Δz over which n_r and $\vec{Q}^2$ are locally constant, in the form,

$$\overline{\psi}(z+\Delta z) = \overline{T}\exp(-j\overline{\beta}\Delta z)\overline{T}^{-1}\overline{\psi}(z_o) \tag{4}$$

Using (4) the solution may be propagated step-by-step through a slowly varying structure.

3. THIRD ORDER ABSORBING BOUNDARY CONDITIONS

Beam propagation algorithms suffer from apparent reflection of diverging waves back into the calculation windows. Absorbing boundary condition are needed to suppress these waves. Here we use the third-order forms for Cartesian coordinates. The approximation is derived as follows. With the notation $D_x^2 \equiv \frac{\partial^2}{\partial x^2}$, $D_z^2 \equiv \frac{\partial^2}{\partial z^2}$ Equation (1) may be written as:

$$L\psi = (D_z^2 + D_x^2 + k_o^2 n^2)\psi = 0 \tag{5}$$

Following [5][6] operator L is then factored into inbound and outbound part L^+ and L^-, so that,

$$L\psi = L^+ L^- \psi = 0 \tag{6}$$

where $L^+\psi = 0$ and $L^-\psi = 0$ are defined as:

$$L^{\pm} = D_x \pm j\sqrt{\varepsilon}\sqrt{1+S^2} \quad , S^2 = \frac{D_z^2}{\varepsilon} \tag{7}$$

and,

$$\varepsilon = k_o^2 n^2$$

The '+' and '–' signs correspond to waves in the $+x$ and $-x$ directions, respectively. At the upper boundary walls in Figure 1, a suitable absorbing boundary condition might be constructed by allowing only the waves in $-x$ direction, so that $L^-\psi = 0$; similarly, we assume that $L^+\psi=0$ on the lower boundaries.

Using the third-order approximation, we then write the square root in (7) as,

$$\sqrt{1+S^2} \approx \frac{\{p_o + p_2 S\}}{\{q_o + q_2 S\}} \tag{8}$$

where, p_o, p_2, q_o, q_2 are constants chosen to give exact agreement with the radix for particular values of S, and hence for particular angles of incident on the boundaries. Furthermore by using a simple algebra calculation, the fields at the edge of computational windows can be calculated.

Unfortunately, the presence of the radical in Equation (5) prohibits the direct evaluation of Equation (6). An algebraic approximation of the radical then is needed to produce absorbing boundary conditions that can be implemented numerically with the MoL scheme. The radical can be approximated as [8]:

$$\sqrt{1+S^2} \approx p_0 + p_2 S^2 \tag{9}$$

Here, the choice of the coefficients p_0 and p_2 is dependent on the method of interpolation [8]. However, the values $p_0=1$ and $p_2=1/2$ are normally used.

Equation (6), (7) and (8) are used to determine the unknown field components E_0 and E_{N+1} of the discretised field on the upper and the lower boundaries as shown in Figure 1. After some manipulations these can be expressed as [8] :

$$\begin{aligned} E_0 &= -a_u E_1 + b_u E_2 \\ E_{N+1} &= b_l E_{N-1} - a_l E_N \end{aligned} \tag{10}$$

Where the coefficients a_p and b_p are given by :

$$a_p = \frac{2 + n_d^2}{1 + jn_d}, \quad b_p = -\frac{1 - jn_d}{1 + jn_d}$$

With: $n_d = \Delta x \varepsilon_p^{1/2}$ and $p=u,l$

Where the u and l symbols stand for upper and lower boundary, respectively.

4. NUMERICAL RESULTS

Simulations of slab waveguide based on the previous algorithms were carried out using a window width W=40 μm, a line spacing Δx=0.5 μm and step size Δz=0,5-1.0 μm. The guide is place in the middle of the window; the core size was 5.5 μm, and the core-cladding index difference was Δn=0.005, so that the guide is a single mode guide at a wavelength of 1.55 μm as shown in Figure 1. Transferred fields derived from the MoL scheme and analytical solution (exact solution) is shown in Figure 2.

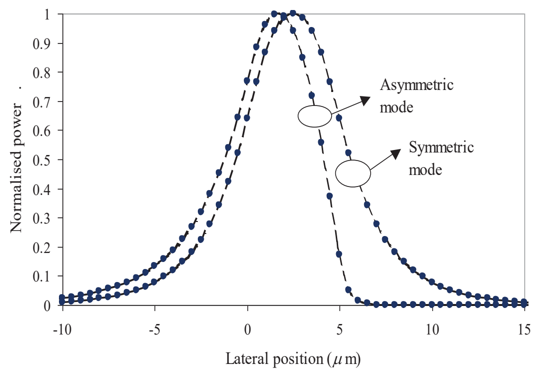

Figure 2. Asymmetric and symmetric mode calculated by using MoL and exact solution.

The solid line represents solution of the exact solution, while the discrete points were obtained from the MoL approximation. It is apparent that the agreement between the solution obtained from the MoL and the exact solution is excellent. Figure 3. shows the effective index profile obtained from both calculation.

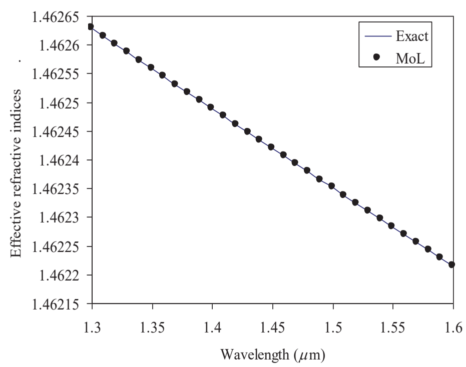

Figure 3. Effective index of an asymmetric waveguide, as calculated by the MoL and by exact solution.

Again the agreement between the two theories is excellent. Further calculation on a V value on based on the definition given in [7] are shown in Figure 4.

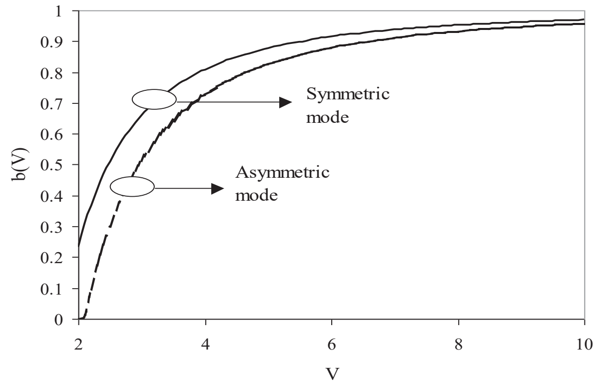

Figure 4. Normalized b-V diagram for asymmetric and symmetric waveguides.

These results show that the MoL scheme can be a versatile tool for simulating a simple waveguide geometry.

5. CONCLUSIONS

It has been shown that the method of lines scheme can be used to calculate simple waveguides structures. Excellent agreements with exact solution of asymmetric and symmetric waveguides can easily be achieved. The third order absorbing boundary condition has further increase the accuracy of the MoL. However, the increasing number of lines used in the calculation windows will increase the computing times.

ACKNOWLEDGMENTS

This work was supported in part by Research and Public Service Institute of University Al Azhar Indonesia (UAI).

REFERENCES

[1] J.A. Fleck, J.R.Morris, M.D. Feit, "Time-dependent propagation of high energy laser beams through the atmosphere", Appl. Physics, vol. 10, 129-160, 1976.

[2] Y. Chung, N. Dagli, "An assessment of finite difference beam propagation method", IEEE J. Of Quantum Electronics, vol. 26, 1335-1339, 1990.

[3] R. Pregla, A. Pascher, "The method of lines", in *Numerical techniques for microwaves and millimeters passive structures*, T. Itoh (Ed), Chapter 6, 381-446, Wiley, New York, 1989.

[4] J. Gerdes, R. Pregla, "Beam propagation algorithm based on the method of lines", J. of Optical Society of Am. B., vol. 8, 389-394, 1991.

[5] T.G. More, J.G. Blaschak, A. Tavlove, G.A. Kriegsmann, "Theory and application of radiation boundary operators", IEEE Trans. Antenna and Propagation, vol. 36, 1797-1812, 1988.

[6] A. Dreher, R. Pregla, "Analysis of planar waveguides with the method of lines and absorbing boundary conditions", IEEE. Microwave and Guided Wave Lett., vol. 1, 138-140, 1991.

[7] D.L. Lee, *Electromagnetic principles of integrated optics*, John Wiley & Sons, Inc, New York 1986

[8] T.G. Moore, J.G. Blaschak, A. Taflove, G.A. Kriegsmann, "Theory and application of radiation boundary operators", IEEE Trans. Antenna and Prop., vol. 36, 1797-1812, 1988