Abstracts

Analysis of the Effective-Index Method for the Vector Modes of Rectangular-Core Dielectric Waveguides

The approximations involved in the effective-index method for analyzing the vector modes of rectangular-core dielectric waveguides are examined in detail. It is shown that the effective-index method does not solve the full vector-wave equation that governs the modes. Instead, it solves the reduced vector-wave equation, which is accurate only for approximately linearly polarized waves. Furthermore, in solving the reduced vector-wave equation, the method of separation of variables is used, which leads to additional errors as the waveguide being analyzed is a mathematically nonseparable structure. To characterize the performance of the effective-index method, asymptotic expressions are derived for the errors in the calculation of propagation constants, Apart from separating the effects of different approximations involved, these expressions show explicitly how the accuracy of the method depends on the mode type, the normalized frequency, the mode orders, the dimensions of the waveguide, and the relative refractive-index differences between the core and the surrounding media. With the help of these expressions, it is demonstrated that more accurate results can be obtained by combining various effective-index solutions.

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