

Master Physique fondamentale et applications

Guided optics

Informations

Composante : Faculté des Sciences

Responsible

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Langue(s) d'enseignement

Anglais

Contenu

The students from different backgrounds elaborate their knowledge in guided optics. They get also a know-how in the theoretical study of waveguides that can be used for more general optical devices. They become familiar with the concept of modes and are able to manipulate them.

1 Main introduction

2 Maxwell's equations

- 2.1 Maxwell's equations
- 2.2 Continuity relations
 - 2.2.1 General case
 - 2.2.2 Perfect conductor case
- 2.3 Constitutive equations
 - 2.3.1 General cases
 - 2.3.2 Frequency domain
 - 2.3.3 Our practical case: a very
- 2.4 Plane waves
- 2.5 Poynting vector

3 Slab waveguide

- 3.1 Introduction
- 3.2 Geometry and indices
- 3.3 TE/TM splitting
- 3.4 Propagation equations
 - 3.4.1 Transverse E waves (TE)
 - 3.4.2 Transverse M waves (TM)
- 3.5 Dispersion equation
 - 3.5.1 Conditions to obtain a guided wave
 - 3.5.2 Form of the electric field profile in the guiding layer
 - 3.5.3 Obtaining of the dispersion equation v for the TE case
 - 3.5.4 field profile in the TE case
 - 3.5.5 Comments on the dispersion equation
 - 3.5.6 Discussion of the dispersion equation
- 3.6 General properties of modes
 - 3.6.1 Mode orthogonality
- 3.7 The symmetric case
 - 3.7.1 Symmetry properties (parity)
 - 3.7.2 Even TE modes in the symmetric slab waveguide
 - 3.7.3 Odd TE modes in the symmetric slab waveguide
 - 3.7.4 Mode numbering
 - 3.7.5 Dispersion curves
 - 3.7.6 Quantization of mode localization in waveguide: confinement factor

4 Propagation of a signal

- 4.1 Introduction
- 4.2 Wave-packet and co
- 4.3 Signal enlargement
 - 4.3.1 Extent of a signal
 - 4.3.2 Distortion of a signal during the propagation

5 Optical fiber

- 5.1 Definition
- 5.2 Technological aspects
 - 5.2.1 Attenuation in optical fibres
 - 5.2.2 Transmission windows
 - 5.2.3 Materials for optical fibres
- 5.3 Initial equations
- 5.4 Form of the solutions

- 5.4.1 Forms of the propagating modes
- 5.4.2 Transverse components of the fields
- 5.4.3 Azimuthal dependency
- 5.5 The circular step-index fiber
 - 5.5.1 Recap equations for the radial dependency
- 5.6 Solutions in the core fibre
- 5.7 Solutions in the cladding
 - 5.7.1 Orthoradial components
 - 5.7.2 Consequences of the continuity relations
- 5.8 Guided modes of the circular SIF
 - 5.8.1 Transverse modes
 - 5.8.2 Hybrid modes HE v,μ and EH v,μ
- 5.9 Cut-Off frequencies
 - 5.9.1 Cut-Off frequencies of TE $0,v$ and TM $0,v$ transverse modes
 - 5.9.2 Cut-Off frequencies of EH v,μ and HE v,μ hybrid modes
- 5.10 Scalar modes
 - 5.10.1 Introduction
 - 5.10.2 Scalar wave equation
 - 5.10.3 Forms of the solutions
 - 5.10.4 Dispersion equations
 - 5.10.5 Mode profiles
 - 5.10.6 Power fraction in the core

Compétences à acquérir

The students

- can derive the dispersion equation for simple waveguides including slab waveguides and step-index optical fibers
- can analyse the dispersion properties of waveguides
- understand the generalization of the waveguide studies for more complex configurations
- manipulate the waveguides guided modes as the solutions of eigenvalue problems
- understand the link between waveguide symmetries and mode classification
- understand the link between waveguide dispersion properties and signal propagation
- know the main technological aspects of optical fibers
- have the knowledge and know-how to understand and use the standard textbooks on this field including for new photonic structures

Modalités d'organisation

Several tutorials are realized during the semester including one on surface plasmon polaritons and one for graded index waveguide.

Bibliographie, lectures recommandées

- K. Okamoto: Fundamentals of optical waveguides
- A. W. Snyder & J. D. Love: Optical waveguide theory
- H. Kogelnik: Integrated Optics,
- D. Marcuse: Light Transmission Optics
- D. Marcuse: Theory of Dielectric Optical Waveguides
- C.-L. Chen: Foundations for guided-wave optics

Pré-requis obligatoires

Mathematical background, fundamentals in Mathematics including basic linear algebra, and vector analysis, basics of wave physics, Maxwell's equations, electromagnetic plane waves

VOLUME HORAIRE

- Volume total: 30 heures
- Cours magistraux: 20 heures
- Travaux dirigés: 10 heures

Codes Apogée

- SPFBU29J [ELP]

Pour plus d'informations

[Aller sur le site de l'offre de formation...](#)



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