Master Physique fondamentale et applications
Fundamental in optics

Responsables

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Descriptions

Code : SPFAU19

Nature : Unité d'enseignement

Domaines : Sciences et Technologies

Informations

Composante : Faculté des Sciences

LANGUE(S) D'ENSEIGNEMENT

Anglais

CONTENU

Fundamentals I: Introduction to electrodynamics

I. Electrostatics and distribution theory.
II. Magnetostatics (and some special relativity).
III. Fields with time variation : Maxwell's equations (Faraday's induction and Maxwell-Ampère theorem). Understanding the equations : a vector analysis synthesis.
IV. Macroscopic Maxwell's equations in media. Integral form of the Maxwell's equations. Electromagnetic energy.
V. Wave equations, EM plane waves, Snell-Descartes law and Fresnel coefficients.
VI. Fourier transforms of functions and distributions.
VII. Maxwell's equations in the frequency domain, dispersive materials and the Kramers-Kronig relations.
VIII. Helmholtz equation, Green functions, and the integral integral theorem of Helmholtz-Kirchhoff.
IX. Electromagnetic radiation.

Fundamentals II: Electromagnetic optics

1. Introduction to electromagnetic waves and optics
1.1. General introduction and preliminary remarks
1.2. From constitutive relations to dispersion equation
1.2.1. Generalities
1.2.2. A bit more about permittivity
1.2.3. Dispersion equation
1.3. Polarization of electromagnetic waves
1.3.1. General considerations
1.3.2. Some useful properties
1.3.3. Linear and circular polarization
1.3.3.1. Linear polarization
1.3.3.2. Circular polarization
1.4. Notions of spatial wave packets
1.4.1. Towards a 2D−problem
1.4.2. Packets of cylindrical waves
1.4.3. Packets of plane waves

2. Stratified media
2.1. Introduction
2.2. Decoupling in TE and TM waves of an arbitrary polarized incident plane wave
2.3. Reflection and transmission of a plane wave at a plane interface
2.3.1. TE case
2.3.2. TM case
2.4. Energetic considerations − Coefficients of reflection and transmission in energy
2.5. Reflection and transmission of a plane wave by a slab
2.5.1. Complex coefficients of reflection and transmission
2.5.2. A first approach of lenses
2.5.3. Introduction
2.5.4. Transfer function for a plano-convex lens
2.5.5. Transfer function for other thin lenses

3. From Fresnel to Fraunhofer
3.1. Introduction
3.2. Fresnel transform
3.2.1. Packets of plane waves : a second approach
3.2.2. Fresnel approximation
3.3. Properties of the Fresnel transform
3.3.1. The Fresnel transform is an operator of convolution
3.3.2. Fresnel vs Fourier
3.4. A first approach of Fraunhofer optics : Fresnel at "infinite" distance
3.5. A second approach of Fraunhofer optics : Fresnel Optics in using a convergent thin lens

COMPÉTENCES À ACQUÉRIR

- Understand the basic principles of electromagnetism and how they are interconnected.
- Know how to perform computations using vector analysis, Fourier transformation, and distribution theory to set up and solve simple electromagnetic problems.
- Understand that magnetism is a relativistic effect and that the observations do not depend on the inertial frame (velocity is relative) while the radiation is due to charge acceleration.
- Understand the difference between general laws (macroscopic Maxwell's equations) and constitutive laws specific to materials.
- Understand the concepts of electromagnetic energy, power density, and forces.
- Understand how the electromagnetic waves are radiated and propagates, and the optics is the study of electromagnetic waves propagation with some simplifying assumptions.
- Be able to perform dimensional analysis to get physical information with a minimum of work.

MODALITÉS D'ORGANISATION

The course will alternate between lectures and tutorials.

BIBLIOGRAPHIE, LECTURES RECOMMANDÉES

1. Gbur, 2011, Mathematical Methods for Optical Physics and Engineering. As mentioned in the title, this textbook tackles the realm of Optics with a rather mathematical flavour. Available at the library on request.
2. Novotny and Hecht, n.d., Principles of Nano-Optics. All fashionable topics. . . Available at the library on request.
3. Hecht, 2002, Optics. Well suited for beginners. Available at the library on request.
4. Goodman, n.d., Introduction To Fourier Optics. For students interested in classical optics and especially Fresnel and Fourier optics. Outstanding monography but for complementary readings.
5. Marcuse, n.d., Light Transmission Optics. For the students interested in classical optics, waveguides, lenses, etc. . . Complementary readings (About 400 pages). Available at the library on request.
6. Sharf, n.d., From Electrostatics To Optics : A Concise Electrodynamics Course. For master students : Chapters I to IV. Available at my office on request.
7. Jackson, n.d., Classical Electrodynamics. For master students : Chapters VI, VII and IX partly (Too) comprehensive book in Optics (about 800 pages !). Available at my office on request.
8. Born and Wolf, 2002, Principle of Optics. For master students : Chapters I and II. (Too) comprehensive book in Optics (about 1000 pages !).
9. Saleh and Teich, 2007, Fundamentals of Photonics. Very comprehensive book (About 1200 pages!!) suited for master students. This monograph tackles the main topics in Photonics in a very pedagogical fashion with its abundant and well illustrated coloured figures with a minimum of mathematical background. (See amongst other Ch. I to VI) Available at library on request.
10. D. J. Griffiths: Introduction to Electrodynamics

11. G. van Dijk: Distribution theory, Convolution, Fourier transform, and Laplace transform
12. J. I. Richards, H. K. Youn: The theory of distributions - A nontechnical introduction
13. V. S. Vladimirov: Generalized Functions in Mathematical Physics

PRÉ-REQUIS OBLIGATOIRES

Solid mathematical background, basic knowledge in Physics, Electrodynamics and Optics

VOLUME HORAIRE

- Volume total: 60 heures
- Cours magistraux: 40 heures
- Travaux dirigés: 20 heures

CODES APOGÉE

- SPFAU19J [ELP]

M3C

Aucune donnée M3C trouvée

POUR PLUS D'INFORMATIONS

Aller sur le site de l'offre de formation...

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