Mathematics in Photonics (E002640)

Due to Covid 19, the education and evaluation methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

Course Specifications
Valid as from the academic year 2020-2021

Course size
( nominal values; actual values may depend on programme)

Credit 4.0
Study time 120 h
Contact hrs 30.0 h

Course offerings and teaching methods in academic year 2020-2021

A (semester 1) English Gent lecture 15.0 h
seminar: coached 15.0 h
exercises

Lecturers in academic year 2020-2021
Biensman, Peter TW05 lecturer-in-charge

Offered in the following programmes in 2020-2021

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<td>Bridging Programme European Master of Science in Photonics</td>
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Teaching languages

Dutch, English

Keywords

applied mathematics, photonics

Position of the course

Exposing the student to various mathematical concepts often used in photonics. The aim is to make the student acquainted with the basic principles and references, in order to allow him to independently further research these concepts.

Contents

- 1: Complex analysis: wave problems as problems from complex analysis, complex functions, analytic functions, derivatives, line integrals, poles, zeros, branch cuts, residue calculus, limit theorems, Cauchy principal value, Kramers-Kronig dispersion relation, conformal transformations, bend losses in optical waveguides
- 2: Special functions: modes of an optical fibre, Bessel and Neuman functions, generating functions, recursion relations, integrals, orthogonality, series expansion, higher order solutions of the paraxial wave equation, Hermite polynomials, generating function, recurrence relation, differential equation, orthogonality, series expansion
- 3: Numerical techniques: finite elements, finite differences, variational methods, eigenmode expansion, method of weighted residuals
- 4: Periodicity and symmetry in photonic systems: using symmetries to classify modes, Bloch theorem, band diagrams, photonic crystals
- 5: Dynamical systems: origins of non-linearity in optical systems, stability, fixed points, the logistic map, saddle points, bifurcations, chaos, period doubling, Lyaponov exponent, stable and unstable manifold

Initial competences

mathematics from the bachelor program

Final competences

1 being able to apply complex analysis to photonic problems
2 being able to apply special functions and orthogonal polynomials to photonic problems
3 getting a basic insight in the effects of symmetry on photonic systems
4 getting a basic insight into numerical techniques for photonics
5 being able to study the dynamics of a photonic system
6 being able to study a new mathematical topic in an independent and critical manner and apply it in a creative way

(Approved)
Access to this course unit via a credit contract is determined after successful competences assessment.

This course unit cannot be taken via an exam contract.

Guided self-study, lecture, seminar: coached exercises.

Full lecture notes.

Open book examination, oral examination.

During examination period: oral open-book exam.

Extra information on the examination methods
- Not applicable.

Calculation of the examination mark.