GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Mathematics in Photonics (E002640)

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

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 1)	English	Gent	seminar
O (semester 1)	English	Gent	

Lecturers in academic year 2024-2025

Bienstman, Peter	TW05	lecturer-in-charge

Offered in the following programmes in 2024-2025	crdts	offering
Bridging Programme Master of Science in Photonics Engineering	4	A
Master of Science in Photonics Engineering	4	A, O

Teaching languages

English, Dutch

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. Supplement: Kramers-Kronig receivers.
- 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

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture, Independent work

Study material

Type: Handouts

Name: full lecture notes
Indicative price: Free or paid by faculty
Optional: no
Additional information: free of charge

Type: Audiovisual Material

Name: Videos
Indicative price: Free or paid by faculty
Optional: no

References

Course content-related study coaching

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Oral assessment open-book

Examination methods in case of periodic assessment during the second examination period

Oral assessment open-book

Examination methods in case of permanent assessment

Participation

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible

Calculation of the examination mark