

Non-linear Optics (E023940)

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 2025-2026

A (semester 1)	English	Gent	seminar independent work lecture
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Lecturers in academic year 2025-2026

Kuyken, Bart	TW05	lecturer-in-charge
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Offered in the following programmes in 2025-2026

	crdts	offering
Bridging Programme Master of Science in Photonics Engineering	4	A
Master of Science in Photonics Engineering	4	A
Master of Science in Silicon Photonics	4	A

Teaching languages

English

Keywords

optics, non-linear optics

Position of the course

This course will familiarize the student with the concepts and methods of non-linear optics and with its applications. Through this course the student will be able to start reading the specialized literature and to start research in this field.

This course is taught at UGent in the first semester.. A teleclassing system is used to limit the student travel between VUB and UGent.

Contents

- Introduction
- Origin of optical non-linearity: Microscopic model, Resonant and non-resonant non-linearity
- Polarisation and susceptibility: General description of macroscopic polarisation, Symmetry properties of non-linear susceptibility, Non-linear wave equation (slowly varying envelope approximation)
- Second order effects: Coupled wave equations, Phase matching methods, Manley-Rowe, Sum frequency and second harmonic generation, Difference frequency generation and parametric amplification
- Third order effects: Four-wave mixing, Intensity dependent refractive index, Self-focusing, self-phase modulation, bistability, supercontinuum and comb generation
- Non-linear scattering: Spontaneous and stimulated scattering, phonons, Brillouin scattering, Raman scattering
- Resonant (or indirect) optical non-linearities: non-linearities induced by plasma effect, band filling effects, thermo-optic effect, optical forces etc
- Non-linear optical materials: glasses, semiconductors, ferroelectrics, polymers

Initial competences

In depth knowledge of linear wave propagation, and of linear optical properties of materials.

Final competences

- 1 Understanding of the most important phenomena in non-linear optics.
- 2 Knowledge of the most important non-linear materials and understanding of the order of magnitude of typical non-linear effects.
- 3 Skills in the mathematical treatment of non-linear optics.

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

None

References

- R.W.Boyd, Non-linear optics, 2nd edition, Elsevier 2003.
- Optical waves in Crystals , Propagation and control of laser radiation door Amnon Yariv en Pochi Yeh

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

Skills test

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

During examination period: oral open-book exam, written preparation. During semester: homework assignments.

Calculation of the examination mark