

## 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 2023-2024**

Offering	Language	Location	Teaching Methods
A (semester 1)	English	Gent	lecture independent work seminar
O (semester 1)	English	Gent	

**Lecturers in academic year 2023-2024**

Kuyken, Bart

TW05

lecturer-in-charge

**Offered in the following programmes in 2023-2024**

[Bridging Programme Master of Science in Photonics Engineering](#)  
[Master of Science in Photonics Engineering](#)

crdts	offering
4	A
4	A, O

**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

**Learning materials and price**

Non-linear optics: syllabus (in English).

**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**