GHENT UNIVERSITY

# Course Specifications

Valid as from the academic year 2024-2025

## Waves and Optics (C004208)

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

**Credits 5.0** **Study time 150 h**

**Course offerings and teaching methods in academic year 2024-2025**

| | | | |
|---|---|---|---|
| A (semester 2) | Dutch | Gent | seminar |
| | | | lecture |

**Lecturers in academic year 2024-2025**

| | | |
|---|---|---|
| Vrielinck, Henk | WE04 | lecturer-in-charge |
| Smet, Philippe | WE04 | co-lecturer |

| Offered in the following programmes in 2024-2025 | crdts | offering |
|---|---|---|
| Bachelor of Science in Physics and Astronomy | 5 | A |
| Preparatory Course Master of Science in Physics and Astronomy | 5 | A |
| Preparatory Course Master of Science in Physics and Astronomy | 5 | A |

**Teaching languages**

Dutch

**Keywords**

Elastic and electromagnetic waves, geometrical optics, interference, diffraction.

**Position of the course**

This course unit belongs to the learning pathway "General physics" in the Bachelor program Physics and Astronomy.
The objective of this course is the study of the elastic and electromagnetic waves, of the related physical phenomena and of the equations which formally decribe them. This is to be seen in the context of the objectives of the bachelor in Physics and astronomy, i.e. to lead to the knowledge of the basic courses and to the capacity to develop abstract physico-mathematical models for experimental observations.

**Contents**

**Waves in an elastic medium**
Mathematical description and wave equation – superposition and Fourier analysis – derivation of the wave equation: one-dimensional examples – group velocity – energy transport, intensity – waves in 2 and 3 dimensions, plane waves, spherical waves

**Sound waves**
Wave equation – displacement, pressure and density waves – phase velocity – intensity, dB scale – Doppler effect

**Electromagnetic waves**
Wave equation and properties of plane electromagnetic waves – energy and linear momentum, radiation pressure – sources: oscillating electric and magnetic dipole – particle-wave duality for light: photons, photoelectric and Compton effect - Doppler effect for electromagnetic waves

**Wave fronts, rays, reflection and refraction**
Huygens' principle – laws of reflection and refraction of plane waves – amplitude of reflected and refracted wave, Fresnel coefficients for electromagnetic waves – Fermat's principle - propagation of electromagnetic waves in anisotropic and inhomogeneous media

**Geometrical optics**
Principles of ray optics – plane and spherical mirrors – refraction at a spherical surface – prism – lenses – optical instruments: telescope and microscope – aberrations

**Interference**
Interference of waves from two synchronous sources – interference of a higher number of coherent sources

**Diffraction**

Fraunhofer diffraction at a rectangular slit – Fraunhofer diffraction at a circular aperture ; relevance for astronomical instruments – Fraunhofer diffraction by two identical, parallel slits, diffraction gratings – spectroscopy and spectral resolution – polarization of waves

**Standing waves**

Standing waves in one dimension – standing waves and the wave equation – standing electromagnetic waves – standing waves in two dimensions – standing waves in three dimensions, cavities – waveguides

**Initial competences**

Classical and relativistic kinematics and dynamics, analysis, electricity and magnetism.

**Final competences**

1 Profound knowledge about wave phenomena in elastic media and electromagnetic waves.
2 Being able to describe waves mathematically and insight in the mathematical abstractions and approximations that lead to the wave equation.
3 Recognizing waves as carriers of energy, momentum and information.
4 Profound understanding of wave properties (reflection, refraction, polarization, interference, diffraction), which are also important in the study of quantum mechanics.
5 Being able to apply the principles of geometrical and physical optics for understanding and designing optical instruments for physics and astronomy.

**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

**Study material**

Type: Syllabus

Name: Waves and optics
Indicative price: € 6
Optional: no
Language : Dutch
Number of Pages : 205
Oldest Usable Edition : edition 2023-2024
Available on Ufora : Yes
Online Available : No
Available in the Library : No
Available through Student Association : Yes
Additional information: The syllabus contains most of the theory to be known for the exam of this course. For part of the theory, the course relies on the handbooks Physics by D. C. Giancoli, Part 1 and part 2. Students that have followed the courses Mechanics and Electricity and magnetism already have these handbooks. They are not obligatory for this course. The syllabus in printed form may be used during the exercises part of the exam for this course. The syllabus is distributed by WiNA.

**References**

- "Natuurkunde" deel 2 "Elektriciteit, magnetisme, optica en moderne fysica", by D.C. Giancoli, ISBN 9781447980247
- "Fundamentele Natuurkunde" deel 3 "Golven" ("Fundamental Physics" part 3 "Waves"), M. Alonso and E.J. Finn, Delta Press, ISBN 90 6674 604 1

**Course content-related study coaching**

During the theory, fundamental concepts are introduced that provide insight in this matter.
During the exercises, the student's attitudes and aptitudes are developed proper to this course.
Interactive feedback is enhanced via Ufora.

**Assessment moments**

end-of-term assessment

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

Written assessment with open-ended questions

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

Written assessment with open-ended questions

**Examination methods in case of permanent assessment**

**Possibilities of retake in case of permanent assessment**

not applicable

**Extra information on the examination methods**

- The exam consists of theory questions and exercises.
- For the theory only a formulary may be used (see Ufora).
- For the exercises a calculator and the syllabus may also be used.

**Calculation of the examination mark**

- Theory: 10 points
- Exercises: 10 points

Total: 20 points