GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2023-2024

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

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

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

Study material

None