GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2018-2019

Waves and Optics (C002022)

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

Credits 6.0	Study time 180 h	Contact hrs	52.5 h

Course offerings and teaching methods in academic year 2018-2019

A (semester 2)	Dutch	seminar: coached exercises	22.5 h
		lecture	30.0 h

Lecturers in academic year 2018-2019

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

Offered in the following programmes in 2018-2019	crdts	offering
Bachelor of Science in Physics and Astronomy	6	A
Preparatory Course Master of Science in Physics and Astronomy	6	A

Teaching languages

Dutch

Keywords

Elastic and electromagnetic waves, geometrical optics, interference, diffraction

Position of the course

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 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 the experimental observations.

Contents

Waves in an elastic medium
Introduction-mathematical description of the propagation of waves-Fourier analysis of a wave motion-elastic waves in a rod-pressure waves in a gas column-transversal waves in a string-surface waves on a fluid-transfer of linear momentum and energy by waves-two and threedimensional waves-spherical waves-Doppler effect for acoustic waves-sound-acoustics.
Electromagnetic Waves
Introduction-plane electromagnetic waves-energy and linear momentum of an electromagnetic wave-radiation of an oscillating electrical and magnetic dipole-radiation of higher order multipoles-radiation of an accelerated charge-scattering of electromagnetic waves by bound electrons-scattering of electromagnetic radiation by a free electron-Compton effect-photon-propagation of electromagnetic waves in matter-dispersion-Doppler effect for electromagnetic waves-the spectrum of electromagnetic radiation.
Reflection, Refraction and Polarisation of Waves
Introduction-Huygens' principle-Malus' theorem-reflection and refraction of plane and spherical waves-amplitude of reflected and refracted wave-reflection and refraction of electromagnetic waves-propagation of electromagnetic waves in an anisotropic medium-dichroism-birefringence-optical activity-reflection and refraction at metallic surfaces-propagation of waves in an inhomogeneous medium.
Geometrical Optics
Introduction-reflection at a spherical surface-refraction at a spherical surface-lenses-optical instruments-the prism-dispersion-astigmatism-chromatic aberration-Fermat's principle.
Interference

Introduction-interference of waves from two synchronous sources- interference of a higher number of coherent sources-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.
Diffraction
Introduction-Fraunhofer diffraction at a rectangular slit-Fraunhofer diffraction at a circular aperture ; relevance of this effect for astronomical instruments-Fraunhofer diffraction by two identical, parallel slits, diffraction gratings-diffraction of X-rays by crystals.

Initial competences

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

Final competences

1 The students have a profound knowledge about wave phenomena in elastic media and electromagnetic waves.
2 The students are able to describe waves mathematically and have insight in the mathematical abstractions and approximations that lead to the wave equation.
3 The students recognize waves as carriers of energy, momentum and information.
4 The students have a profound understanding of wave properties (reflection, refraction, polarization, interference, diffraction), which are also important in the study of quantum mechanics.
5 The students can 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

Lecture, seminar: coached exercises

Learning materials and price

"Natuurkunde" deel 2 "Elektriciteit, magnetisme, optica en moderne fysica", by D.C. Giancoli, ISBN 9781447980247
Price: approximately € 75
Additional lecture/extra information via Minerva.
Slides of the lectures via Minerva.

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 Minerva.

Evaluation methods

end-of-term evaluation

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

Written examination with open questions

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

Written examination with open questions

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation

not applicable

Extra information on the examination methods

The exam consists of two theory questions and two exercises.
For the theory only a formulary may be used (see Minerva).
For the exercises the textbook and a calculator may also be used.

Calculation of the examination mark

Two questions theory, each 5 points
Two exercises, each 5 points
Total: 20 points