GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Materials Physics (C004141)

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

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2025-2026

A (semester 1)	English	Gent	lecture
			seminar

Lecturers in academic year 2025-2026

Hens, Zeger	WE06	lecturer-in-charge
Cottenier, Stefaan	TW08	co-lecturer

Offered in the following programmes in 2025-2026	crdts	offering
Master of Science in Teaching in Science and Technology(main subject Chemistry)	6	A
Master of Science in Chemistry(main subject Materials and Nano Chemistry)	6	A
Master of Science in Chemical Engineering	6	A
Master of Science in Chemical Engineering	6	A
Exchange Programme in Chemistry (master's level)	6	A

Teaching languages

English

Keywords

Position of the course

The course teaches students materials physics, using a dual track where the main concepts are introduced through analytical model systems and detailed by a computational approach. The course covers a typical selection of topics in solid-state physics, including a description of crystal lattices and an introduction to reciprocal space through the problem of diffraction. Next, crystal binding is addressed, together with the mechanical and thermal properties of crystals. Electronic states in solids are addressed from the free electron gas to band-theory. Optical properties of metals and semiconductors are discussed and so are the main solid-state devices, including photovoltaic cells, photodiodes and light emitting diodes. The modules (1) concepts in materials physics and (2) computational materials physics can be followed as Advanced Topics in Chemistry.

Contents

Conceptual material physics
1 Crystal structures – point groups and space groups, main crystal structures.
2 Diffraction from crystals – introducing reciprocal space.
3 Crystal binding and elasticity – stress and strain.
4 Phonons – lattice vibrations and the heat capacity of solids.
5 Quantum statistics – the distribution of bosons and fermions over energy levels.
6 Electronic states in solids – from the free electron gas to energy bands.
7 Semiconductors – electrons, holes and the effective mass model.
8 Otical properties of solids – metal versus semiconductors
9 Semiconductor devices – using the *p-n* junction for converting, detecting and emitting light.
Computational material physics
Using a general purpose density functional theory code to:
1 Calculate total energies of crystals
2 Calculate crystal geometries

3 Calculate energy band structures
4 Calculate elastic crystal properties
5 Calculate phonon dispersion relations

Initial competences

Students have a background in mathematics for chemists, basic physics and materials chemistry.

Final competences

1 Students understand the symmetry properties of crystals and can implement crystal structures in a computational tool.
2 Students can use reciprocal space to describe diffraction from crystals and can calculate the reciprocal lattice of a given real space lattice
3 Students know qualitative approaches to describe crystal binding and can use computational methods to evaluate the stability of crystals.
4 Students can describe lattice vibrations as wave phenomena, can extend this picture to obtain quantized oscillators or phonons and compute the phonon dispersion relation of a given material.
5 Students have insight in quantum statistics and use quantum statistics to describe the distribution of phonons or electrons over the available energy levels.
6 Students have insight in the band theory of solids and can calculate the band structure of a given material.
7 Students are familiar with approximative methods to describe the electronic properties of semiconductors and know how these methods are related to the semiconductor band structure.
8 Students can describe the optical properties of metals and semiconductors in terms of their electronic structure.
9 Students can explain the properties of a *p-n* junction and the use of this device for conversion, detection and emission of light.

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

Extra information on the teaching methods

The part on computational materials physics will be offered as an on-line course with dedicated feedback sessions.

Study material

Type: Syllabus

Name: Course notes'
Indicative price: Free or paid by faculty
Optional: no

References

- Introduction to Solid State Physics, Charles Kittel

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

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

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

Periodegebonden en niet-periodegebonden valuatie

Calculation of the examination mark

- Niet-periodegebonden 2/20
- Periodegebonden theorie-examen 10/20
- Periodegebonden oefeningexamen 8/20