

## Physics and Chemistry of Nanostructures (C003120)

**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 2024-2025**

Offering	Language	Location	Teaching Methods
A (semester 2)	English	Gent	
B (semester 2)	English	Gent	lecture seminar

**Lecturers in academic year 2024-2025**

Hens, Zeger	WE06	lecturer-in-charge
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**Offered in the following programmes in 2024-2025**

Programme	crdts	offering
<a href="#">Master of Science in Teaching in Science and Technology(main subject Physics and Astronomy)</a>	6	B
<a href="#">Master of Science in Biomedical Engineering</a>	6	B
<a href="#">Master of Science in Biomedical Engineering</a>	6	B
<a href="#">Master of Science in Photonics Engineering</a>	6	B
<a href="#">Master of Science in Physics and Astronomy</a>	6	B
<a href="#">Master of Science in Physics and Astronomy</a>	6	A
<a href="#">Exchange Programme in Physics and Astronomy (Master's Level)</a>	6	A

**Teaching languages**

English

**Keywords**

Nanoscience and technology, colloidal nanocrystals, self-assembly, quantum confinement, quantum transport

**Position of the course**

Physics and Chemistry of nanostructures is an optional course of the master in physics program, dealing with nanoscience and technology. It addresses physical phenomena at the nanoscale, the synthesis of nanoscale objects and techniques for measurement and manipulation at the nanoscale. The goal of the course is to make students understand (1) the driving force behind miniaturization, (2) how to make nanoscale objects, (3) the dependence of materials properties on size and (4) the operation of nanoscale devices. The course relies strongly on recent literature. During the course, students will learn how to read, understand and use scientific literature.

**Contents**

1. Introduction: nanoscience and technology: what, why and how - observation, measurement and manipulation at the nanoscale.
2. Concepts of bottom-up nanotechnology: syntheses of colloidal nanocrystals - self-assembly as a construction principle.
3. Physical properties of nanoscale materials: electronic energy levels in nanostructures - quantum confinement - optical properties of quantum dots.
4. Quantum transport: tunneling - single-electron tunneling and Coulomb-blockade - tunneling spectroscopy - electron counting - the quantization of conductance.
5. Nanoscale devices: the single-electron transistor.

**Initial competences**

Chemie.  
Vaste-stoffysica.

### Final competences

- 1 Students can explain the rationale of nanoscience and technology and discuss the main trends in bottom-up nanotechnology.
- 2 Students understand colloidal nanocrystals in terms of synthesis, stability and processing.
- 3 Students have insight in self-assembly as a bottom-up approach to nanostructures.
- 4 Students can explain why material properties may depend on particle size.
- 5 Students can relate quantum confinement to the physical properties of semiconductor nanocrystals.
- 6 Students understand quantum transport by tunneling.
- 7 Students can relate Coulomb-blockade to single electron tunneling and understand the functioning of devices based in this effect.
- 8 Students can discuss about the quantization of conductance.
- 9 Understand can read, assess and discuss current scientific literature on colloidal nanocrystals.

### 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

### Study material

Type: Syllabus

Name: Syllabus

Indicative price: Free or paid by faculty

Optional: no

Additional information: available through Ufora

### References

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### Course content-related study coaching

Interactive support by means of Minerva. Questions and discussions during and after the classroom lectures. Personal assistance for the preparation of presentations

### Assessment moments

end-of-term assessment

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

Oral assessment, Assignment

### 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

examination during the second examination period is possible in modified form

### Extra information on the examination methods

To be evaluated, each student has to write and present a review on a recent publication on a topic in nanoscience related to the course. The review is written in a two-step process. Only after a first version has been peer-reviewed by fellow students, a second version is submitted for evaluation. The evaluation is based on the written report, the presentation and the discussion following the presentation.

### Calculation of the examination mark

A single mark is given to the whole of review, presentation and discussion.