GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2023-2024

Nuclear Methods in Material Research (C003122)

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 2023-2024

A (semester 2)	English	Gent	independent work
			lecture

Lecturers in academic year 2023-2024

Cottenier, Stefaan	TW08	lecturer-in-charge

Offered in the following programmes in 2023-2024	crdts	offering
Master of Science in Teaching in Science and Technology(main subject Physics and Astronomy)	6	A
Master of Science in Materials Engineering	6	A
Master of Science in Physics and Astronomy	6	A
Master of Science in Sustainable Materials Engineering	6	A
Exchange Programme in Physics and Astronomy (Master's Level)	6	A

Teaching languages

English

Keywords

nuclear methods, hyperfine interactions, materials research

Position of the course

The term 'nuclear methods' refers here to experimental tools in materials physics in which stable or radioactive atomic nuclei play a key role. Such methods are valuable for studying structural or magnetic properties of (defects in) materials at an atomic scale.

Contents

- Phenomenological description of an atomic nucleus: radius, spin, parity, electric and magnetic multipole moments, coupling of angular momenta, radioactive decay, multipole radiation.
- Hyperfine interactions and their relation with various energy scales in atoms.
- Multipole expansion of the charge-charge and current-current interaction between a nucleus and an electron distribution.
- Magnetic hyperfine interaction, electric quadrupole interaction, monopole and quadrupole shift.
- Experimental methods based on hyperfine interactions: nuclear magnetic resonance, nuclear quadrupole resonance, electron paramagnetic resonance, laser spectroscopy, low-temperature nuclear orientation, NMR on oriented nuclei, Mössbauer spectroscopy, perturbed angular correlation, resonant scattering of synchrotron radiation.
- Academic, industrial and analytic applications of these methods.
- Whenever possible and relevant, labs at UGent will be visited where nuclear methods are used.

Initial competences

basics of modern physics

Final competences

1 Explaining the relations and differences between the major nuclear methods.
2 Explaining the physical background behind the major nuclear methods.

3 Being aware of which properties can and which cannot be measured by nuclear methods.
4 Grasping the relevant information from research papers that report on experiments with nuclear methods.
5 Being able to read and interpret simple experimental spectra obtained by nuclear methods.
6 Being aware of the range of applications of nuclear methods.

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, Independent work

Extra information on the teaching methods

This course is taught according to a **flipped classroom** method: you receive every week a set of video and text files for self-study, together with a set of questions and tasks. The answers have to be uploaded 24h before the weekly class session. During this class session, there will be no traditional lecture. Instead, we zoom in on misconceptions that were revealed by the tasks, and we provide ample time to remediate problems you or your fellow students might have encountered during the past week. It is your choice whether you attend this feedback session in the lecture room, via a livestream, or whether you watch a recorded version later. This course is accessible as an open online course for anyone, **worldwide**, via www.hyperfinecourse.org. Whenever possible, we try to establish interactions between students in Ghent and volunteering participants on other continents.

Learning materials and price

15 hours of dedicated video material (screencasts) that was made for this course, together with a selection of papers from the recent research literature. Available via www.hyperfinecourse.org.
Cost: 0 EUR

References

- "*Nuclear condensed matter physics - nuclear methods and applications*" by Günter Schatz, Alois Weidinger (Wiley, ISBN: 0 471 95479 9)

Course content-related study coaching

During the weekly feedback webinar, questions that were submitted during the preceding week are collectively addressed.

Assessment moments

end-of-term and continuous assessment

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

Oral assessment, Written assessment

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

Oral assessment, Written assessment

Examination methods in case of permanent assessment

Participation, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible

Extra information on the examination methods

You are expected to submit weekly a report with your answers to the questions/tasks of that week. Your *effort* in doing so will be evaluated, not the *correctness* of your answers. At the end of the course there is a combined written/oral examination, and then the correctness matters.

Calculation of the examination mark

- weekly report: 20% (per non-submitted report, 5% is subtracted - with a floor of 0%)
- exam: 80%

You have to pass on the item 'exam' in order to pass for the course. If you pass the exam, your points for the exam (on 16) are added to your points for the weekly reports (on 4) to get a final score on 20. In case you don't pass the exam (e.g. 7/16) then your points obtained for the weekly reports (e.g. 3/4) are added only to a maximum of 9 (e.g. 7+2=9, 1 point is discarded).

Facilities for Working Students

All lecture content is permanently available under the form of prerecorded videos. The weekly feedback webinars are live-streamed and recorded.