GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Groups and Representations (C004217)

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

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2025-2026

A (semester 2)	Dutch	Gent	seminar
			lecture

Lecturers in academic year 2025-2026

Verstraete, Frank	WE05	lecturer-in-charge

Offered in the following programmes in 2025-2026	**crdts**	**offering**
Bachelor of Science in Physics and Astronomy	4	A
Preparatory Course Master of Science in Physics and Astronomy	4	A
Preparatory Course Master of Science in Physics and Astronomy	4	A

Teaching languages

Dutch

Keywords

Group theory, representation theory of finite and continuous groups, point and space groups, projective representations

Position of the course

This course unit belongs to the learning pathway "Mathematics" in the Bachelor program Physics and Astronomy.

Contents

1 Group Theory in Physics: Overview (1.5h)
- a. Noethers theorem
- b. Relativity
- c. Nuclear, molecular and atomic spectra
- d. Symmetry breaking
- e. Particle physics

2 Group theory: basics (7.5h)
- a. Introduction, definitions, symmetries in physics
- b. Finite groups, multiplication table, permutation group
- c. Subgroups, normal subgroups, direct products and semi-direct products

3 Representation theory (6h)
- a. Irreducible representations, equivalent representations
- b. Theory of characters and orthogonality theorems
- c. Tensor product representations and reduction to irreps
- d. Representation theory of the permutation group & Young tableaux
- e. Projective representations and applications in quantum mechanics
- f. Real, complex and quaternionic representations, and Kramers' theorem

4 Lie algebras and groups (6h)
- a. Associativity, Lie groups, structure factors
- b. Representation theory of SU(2) and SO(3)
- c. Classification of semi-simple Lie groups: root vectors, Dynkin diagrams
- d. Casimir operators
- e. Peter-Weyl theorem, Haar measure

f. Schur-Weyl duality

5 Crystallography (1.5h)
a. Finite subgroups of the rotation group
b. Point groups, space groups, Bravais lattices
c. Group cohomology
d. Application: wallpaper groups

Initial competences

- Vector and Function Spaces
- Quantum mechanics I

Final competences

Solid basis in group theoretic notion relevant for quantum physics.

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

Study material

Type: Syllabus

Name: Syllabus
Indicative price: Free or paid by faculty
Optional: no
Additional information: available through Ufora

Type: Slides

Name: Lectures slides
Indicative price: Free or paid by faculty
Optional: no
Additional information: available through Ufora

References

- Lecture Notes on Group Theory in Physics - Arovas
- Symmetries, Lie algebras and representations: A graduate course for physicists - Fuchs, Schweigert

Course content-related study coaching

Assessment moments

end-of-term assessment

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

Written assessment

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

Written assessment

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

not applicable

Calculation of the examination mark

written exam, 60% theory, 40% exercises