

## 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 2024-2025**

A (semester 2)

Dutch

Gent

seminar

lecture

**Lecturers in academic year 2024-2025**

Verstraete, Frank

WE05

lecturer-in-charge

**Offered in the following programmes in 2024-2025**

[Bachelor of Science in Physics and Astronomy](#)

[Preparatory Course Master of Science in Physics and Astronomy](#)

[Preparatory Course Master of Science in Physics and Astronomy](#)

**crdts**

**offering**

4

A

4

A

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