GHENT UNIVERSITY

# Course Specifications

Valid as from the academic year 2025-2026

## Field Theory for Statistical Mechanics (C004518)

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

**Credits 6.0** **Study time 180 h**

**Course offerings in academic year 2025-2026**

A (semester 2) English Gent

**Lecturers in academic year 2025-2026**

Bultinck, Nick WE05 lecturer-in-charge

| Offered in the following programmes in 2025-2026 | crdts | offering |
|---|---|---|
| Master of Science in Physics and Astronomy | 6 | A |
| Exchange Programme in Physics and Astronomy (Master's Level) | 6 | A |

**Teaching languages**

English

**Keywords**

Statistical physics, field theory, renormalization

**Position of the course**

**Contents**

1 **Statistical physics and field theory:** Lightening review of the necessary concepts from statistical physics. Path integrals and quantum field theory. The quantum-classical mapping. Universality of long-distance properties and effective field theories. Basic philosophy behind renormalization and the connection to critical exponents.
2 **Momentum-shell renormalization:** Perturbative calculation of the Wilson-Fisher RG fixed point and the critical exponents via the epsilon expansion. The O(N) model as an effective field theory for magntism, and the calculation of the beta function in two dimensions.
3 **2D XY model:** Villain representation of the partition function. The sine-Gordon continuum field theory description. The Berezinskii-Kosterlitz-Thouless phase transition and the Kosterlitz renormalization group analysis.
4 **3D XY model:** Particle-vortex duality and the dual U(1) gauge theory description.
5 **3D compact electrodynamics:** The role of magnetic monopoles for confinement in U(1) gauge theory on the lattice.

**Initial competences**

Statistical mechanics, quantum mechanics, quantum field theory

**Final competences**

1 The student has an understanding of the universality of statistical physics on large length scales, and how this allows for a continuum field theory description.
2 The student can perform calculations in continuum field theory, and is able to use these to derive physical properties.

**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: Field theory for statistical mechanics
Indicative price: Free or paid by faculty
Optional: no

**References**

**Course content-related study coaching**

**Assessment moments**

end-of-term assessment

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

Oral assessment

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

Oral assessment

**Examination methods in case of permanent assessment**

**Possibilities of retake in case of permanent assessment**

not applicable

**Calculation of the examination mark**