

## 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 2024-2025**

null

**Lecturers in academic year 2024-2025**

Bultinck, Nick

WE05

lecturer-in-charge

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

null

crdts

offering

**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.
- 2 **Renormalization:** The Gaussian 'mean-field' theory and rescaling. Engineering dimensions of operators, and the associated concept of the upper critical dimension. Momentum-shell renormalization and the Wilson-Fisher fixed point. The epsilon expansion.
- 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 **O(N) model:** The O(N) model as an effective field theory for (quantum) magnets. Renormalization group analysis of the O(N) model.

**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**

**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**