

Physics III (E020310)

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 2025-2026

A (semester 2)

Dutch

Gent

seminar

lecture

Lecturers in academic year 2025-2026

Vanduyfhuys, Louis

TW17

lecturer-in-charge

Offered in the following programmes in 2025-2026

[Bachelor of Science in Engineering\(main subject Engineering Physics\)](#)

crdts

6

offering

A

[Bridging Programme Master of Science in Engineering Physics](#)

6

A

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

6

A

Teaching languages

Dutch

Keywords

Thermodynamics, statistical physics, partition functions, degrees of freedom

Position of the course

This course elaborates further on the thermodynamics covered in the starting competencies. The course introduces the fundamental principles of classical thermodynamics and statistical physics for system in equilibrium. As such, entropy is introduced in a mathematically and physically rigorous way based on the concept of reversible adiabatic surfaces. Furthermore, special attention is given to partition functions and the theory of ensembles as introduced by Gibbs. The basic distribution functions are derived: the Boltzmann distribution, the Fermi-Dirac and Bose-Einstein distribution. The course deals with the physics of systems with a lot of degrees of freedom and the ability to derive macroscopic properties for such systems. Applications are important in condensed matter physics, low temperature physics, physical chemistry

Contents

PART I : THERMODYNAMICS

1 Basic concepts

2 Zeroth law of thermodynamics

Thermal equilibrium, temperature and thermometers

3 Equations of state

PV, PT and PVT diagrams of pure substances, equations of state, differential equations of state, other thermodynamical systems (paramagnetic, dielectric, wire on tension, ...), equation of state of a gas, the ideal gas law

4 First law of thermodynamics

work, dependence on the followed path, examples quasistatic processes, heat, internal energy, first law of thermodynamics, differential form

5 Heat capacity

heat capacity, quasistatic heat flow, hydrostatic system, internal energy of a gas, ideal gasses

6 Second law of thermodynamics

thermal engines (steam engine, Stirling cycle, Otto cycle, Diesel cycle), interconversion of heat and work, Kelvin-Planck formulation of the second law, heat pumps, Clausius formulation of the second law, equality of both

formulations

7 Reversibility

reversibility and irreversibility, the existence of reversible adiabatic surfaces, integrability of dQ , Kelvin temperature, third law of thermodynamics

8 Entropy

9 Thermodynamical functions

enthalpy, Helmholtz free energy, Gibbs free enthalpy, thermodynamic potential, Legendre transformation, thermodynamic Maxwell equations, TdS equations, energy equation, heat capacity equations

10 Microscopic formulation - Kinetic gas theory

Equations of state for an ideal gas and Van der Waals equation of state

PART II : STATISTICAL PHYSICS

1 The first law of thermodynamics

- 1 general formulation of the first law
- 2 application to hydrostatic systems
- 3 magnetic and electric systems

2 The second and third law in the context of Statistical Physics

- 1 Macrostate and microstate
- 2 equilibrium for isolated systems
- 3 Point defects in crystals
- 4 Equilibrium for a system in a heat bath, Boltzmann distribution, quantum mechanic definition of the partition function
- 5 Characteristic temperature
- 6 Entropy in classical thermodynamics and statistical physics
- 7 the third law of thermodynamics

3 Ensemble theory

- 1 Phase space
- 2 The ensemble concept
- 3 Different types of ensembles
- 4 Boltzmann and gibbs definition of entropy

4 Statistical description of paramagnetics

5 Negative temperatures

6 Specific heat of solids

- 1 Einsteintheory for heat capacity
- 2 Debeyetheory for heat capacity
- 3 Phonons

7 Classical ideal gas

- 1 Statistical description
- 2 Definition of the ideal-gas partition function
- 3 Criterion for the existence of the classical regime
- 4 Equation of state of an ideal gas
- 5 Entropy of an ideal gas
- 6 Molecular partition function (translational, rotational and vibrational contribution), separation of degrees of freedom, application to diatomic and polyatomic gasses, specific heat

8 Ideal quantum gasses - theory

- 1 Gibbsfactor and gibb sum
- 2 Occupation numbers, spin, classical limit, identical indistinguishable particles
- 3 Fermi-Dirac and Bose-Einstein statistics

9 Ideal quantum gasses - applications

- 1 Free electron gas in metals
- 2 super conduction, Bose-Einstein condensatie, black body radiation, and the photon gas

Initial competences

Final competences

- 1 Application of basic concepts of thermodynamics and statistical physics.
- 2 Understand the relation between macroscopic and microscopic description of matter.
- 3 Derivation of partition functions for simple and complicated systems.
- 4 Application of the various statistical distribution functions on systems with a lot of degrees of freedom.

5 Knowledge of thermodynamical concepts and the application on a broad variety of thermodynamical systems.

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: Physics III

Indicative price: € 10

Optional: yes

Language : Dutch

Number of Pages : 380

Available on Ufora : No

Online Available : No

Available in the Library : No

Available through Student Association : No

Additional information: The course material for the course Physics III consists of a syllabus and slides. The slides will be uploaded to Ufora during the academic year and we offer the opportunity to buy the syllabus.

Type: Slides

Name: Slides Physics III

Indicative price: Free or paid by faculty

Optional: no

Language : Dutch

Available on Ufora : Yes

Online Available : Yes

Available in the Library : No

Available through Student Association : No

References

- Baierlein R., Thermal Physics, Cambridge University Press 1999. ISBN 0-521-59082-5.
- Kittel C., Kroemer H., Thermal Physics, W.H. Freeman 1980. ISBN 0-7167-1088-9.
- Mandl F., Statistical Physics, The Manchester Physics Series, 2nd edition, Wiley 1988. ISBN 0-471-91533-5 (paperback).

Course content-related study coaching

Lecturer and assistants are available before and after lectures or by appointment

Assessment moments

end-of-term 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

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

Theory and Exercise exam

Theory : Oral exam with a written preparation for the theory, closed book

Exercises : Written exam, closed book

Calculation of the examination mark

