



Faculty of Health, Science and Technology  
Physics  
Syllabus

**Course Approval**

The syllabus was approved by the Faculty Board of Health, Science and Technology on 13 February 2014, and is valid from the Autumn semester of 2014 at Karlstad University. It replaces the former syllabus approved on 27 May 2008, Reg No FAK2 2008/9:19.

**Course Code:** FYGB02

**Thermodynamics and Statistical Physics, 7.5 ECTS Credits**  
(Termodynamik och statistisk fysik, 7.5 Swedish credit points)

**Degree Level:** Bachelor

**Progressive Specialisation:** G1F (First cycle, has less than 60 credits in first-cycle course/s as entry requirements)

**Language of Instruction**

Swedish or English

**Prerequisites**

Physics, 30 ECTS Credits, and mathematics, 30 ECTS Credits

**Major Field of Study**

FYA (Physics)

**Learning Outcomes**

The aim of the course is that students acquire the fundamentals of classic thermodynamics for closed systems in equilibrium, statistical physics, and statistical thermodynamics. The course also provides the background to significant technical applications and a basis for discussions of energy issues.

Upon completion of the course, students should be able to:

- give an account of the phases of pure substances and describe phase transitions
- analyze processes of closed systems as regards the first and second laws of thermodynamics, especially in relation to pure substances and ideal gases
- apply and describe the consequences of the second law in realistic situations
- calculate thermodynamic properties based on different forms of free energy
- give an account of links between classic and statistical thermodynamics
- give an account of the microscopic significance of entropy
- calculate the microcanonical and canonical ensembles of simple multiparticle systems
- calculate the state sum and free energy of a canonical ensemble
- give an account of the implication of Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics, and apply the corresponding distribution functions.

**Content and Form of Instruction**

Classic Thermodynamics, 4.5 ECTS Credits:

Basic concepts: thermodynamic systems, state, equilibrium, process, cycle. Temperature and the zeroth law of

thermodynamics, internal energy, pressure, enthalpy, work, heat. The phases of pure substances and phase transitions, state diagrams and phase diagrams. Ideal and non-ideal gases. The first law of thermodynamics for closed systems. Changes in the internal energy and enthalpy of ideal gases, heat capacity. Heat reservoir, heat engine, heat pump, and cooling process, the second law of thermodynamics. Reversible and irreversible processes, the Carnot cycle, the thermodynamical temperature scale, reversible heat engines, heat pumps, and cooling processes. Entropy, the principle of increasing entropy, changes in entropy for ideal gases. Analysis of heat engines, ideal cycles. Thermodynamical potentials, Helmholtz and Gibbs free energies, Maxwell's relations.

Statistical Physics, 3.5 ECTS Credits:

Kinetic theory for ideal gases. Probability distribution, mean, and deviation. Bernoulli processes and binomial distribution. Normal distribution, the law of large numbers, the central limit theorem, the connections between macroscopic properties and statistical mechanics. Macrostates and microstates, ensembles. Isolated systems and the microcanonical ensemble, the equiprobability principle, the entropy of isolated systems. Systems in thermal equilibrium with heat reservoirs and the canonical ensemble, the Boltzmann distribution, state sum, response functions and heat capacity, and entropy and the third law of thermodynamics. Free energy and statistical thermodynamics. Entangled particles, the Pauli principle, bosons and fermions. Classic and quantum mechanical ideal gas; the Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac distributions; black body radiation.

Reading List

See separate document.

Examination

Assessment is based on written exams, presentations of laboratory assignments, and hand-in assignments.

Grades

One of the grades Fail (U), Pass (G), or Distinction (VG) is awarded in the examination of the course.

Non-program students are awarded one of the grades Fail (U), Pass (3), Some Distinction (4), or Distinction (5) in the examination of the course.

Quality Assurance

Follow-up relating to learning conditions and goal-fulfillment takes place both during and upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

Course Certificate

A course certificate will be provided upon request.

Additional Information

Students who enrolled before 1 July 2007 will complete their studies in accordance with the requirements of the earlier admission. Upon completion students may request degree and course certificates to be issued under the current ordinance if they meet its requirements.

The local regulations for studies at the Bachelor's and Master's levels at Karlstad University stipulate the obligations and rights of students and staff.

[information@kau.se](mailto:information@kau.se) [www.kau.se](http://www.kau.se)