FSG3131 Kinetic Gas Theory 7.0 credits

Kinetisk gasteori

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for FSG3131 valid from Autumn 2011

Grading scale

G

Education cycle

Third cycle

Specific prerequisites

Recommended prerequisites

An advanced course in fluid mechanics on undergraduate level is recommended.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The student will be able to describe the connection between the continuum mechanical Navier-Stokes equations for a gas and the kinetic theory description of a gas in thermal non-equilibrium. Also, the student will be able to describe some effects typical to gases at Knudsen numbers of order one or larger, a limit not covered by the Navier-Stokes equations.

Course contents

After completing this course the student should be able to:

- Give the kinetic theory definitions of the macroscopic continuum properties/variables of a gas.
- State the requirements on a fluid flow for the continuum assumption to be a reasonable approximation.
- Describe the concepts of cross-section and mean free path in a gas and derive an expression for the mean free path.
- Use the mean free path concept to derive an approximate expression for viscosity and heat conductivity in a gas in terms of kinetic variables.
- State the Boltzmann equation and, make an interpretation of the different terms involved.
- State the Maxwellian distribution and when it is valid.
- Give examples of some typical kinetic effects not described by the Navier-Stokes equations.
- Give the main principles of a Direct Simulation Monte-Carlo Simulation (DSMC).
- Describe in broad outline the Chapman-Enskog method to derive the Navier-Stokes equations from the Boltzmann equation at small Knudsen numbers, in particular how viscosity and heat conductivity can be found from the molecular interactions.

Disposition

About 10 hour lectures.

Project work in groups of 2 students.

Seminars with student project presentations with 2 students per 45 minutes.

Course literature

Course literature

Gombosi, T.I.

Gaskinetic Theory, Cambridge University Press, 1994

Dahlkild, A.A. and Söderholm, L.H.

Lecture notes in kinetic gas theory, 2011

Examination

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Lists of typical questions at examination are available for the oral exam.

Other requirements for final grade

The following items have to be approved in order to obtain a pass on the course:

- Project work and 4-page report on a DSMC-simulation
- Oral examination on kinetic theory of gases

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.