Introduction to Homogenization, 7.5 hp

Course period:
LP4, March 22–June 6, 2021

Last day for application:
March 22, 2021.

Course responsible:
Irina Pettersson, irinap@chalmers.se

Course description:
The course is an introduction to the homogenization theory that is concerned with the averaging of partial differential equations. The theory has applications in porous and composite materials. Mathematical models of non-homogeneous media may contain coefficients or densities that are rapidly oscillating. To compute the characteristics of such media can be difficult, and asymptotic analysis is one way to deal with this difficulty, resulting in homogenization, the notion of an effective medium, and multiscale modelling. Multiscale modelling in physics and technology has shown to be an effective tool in many branches of science. The theory is built using the language of functional analysis, where the Sobolev function spaces play an important role in the analysis.

Responsible department:
Department of mathematical sciences

Teacher:
Irina Pettersson

Examiner:
Irina Pettersson

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1. Confirmation.

Disciplinary domain: Mathematics
Department in charge: Department of mathematical sciences
Main field of study: Analysis

2. Position in the education system.
Elective course on doctoral (third cycle) level.

3. Entry requirements.
Some knowledge on partial differential equations, functional analysis, and Sobolev spaces.

4. Course contents.
The course covers the preliminaries of

- spaces of periodic functions,
- weak limits of rapidly oscillating periodic functions,
- Poincaré and Fridrichs inequalities, and
- variational elliptic problems,

and discusses the topics of

- homogenization of second order elliptic and parabolic operators with periodic coefficients,
- homogenization in perforated domains and domains with inclusions,
- spectral problems in homogenization theory, and
- homogenization of nonlinear variational problems.

The asymptotic expansions method, the method of oscillating test functions, and the two-scale convergence will be introduced.

5. Learning outcomes.
After passing the course, the student is expected to be able to demonstrate understanding of the main concepts and the basic results of the homogenization theory.

6. Suggested reading.

1. Cioranescu, D., and Donato, P., An introduction to homogenization. Vol. 17. Oxford: Oxford University Press, 1999.
2. Berlyand, L. and Rybalko, V., Getting Acquainted with Homogenization and Multiscale. Springer International Publishing, 2018.

7. Assessment.
Written hand-in assignments and a seminar on a topic relevant for the course.

8. Grading scale.
The grading scale comprises Pass (G) and Fail (U).

9. Course evaluation.
The course will be evaluated using discussions during the course, as well as an individual, anonymous survey after the course.

10. Language of instruction.
English.