Reg No: MAAD28/20222

Faculty of Health, Science and Technology
Mathematics

Syllabus

Homogenization: multiscale modeling, analysis and simulation

Course Code:	MAAD28
Course Title:	Homogenization: multiscale modeling, analysis and simulation *Homogenisering: flerskalemodellering, analys och simulering*
Credits:	7.5
Degree Level:	Master's level
Progressive Specialisation:	Second cycle, has only first-cycle course/s as entry requirements (A1N)

Major Field of Study:
MAA (Mathematics)

Course Approval
The syllabus was approved by the Faculty of Health, Science and Technology 2022-02-07, and is valid from the Autumn semester 2022 at Karlstad University.

Prerequisites
Mathematics 90 ECTS credits, including at least 30 ECTS credits at the G2F level, or equivalent

Learning Outcomes
Upon completion of the course, students should be able to:
- recognise relevant separated scales and types of multiscale problems,
- select appropriate small parameters required for asymptotic developments,
- formally scale up microscopic systems using arguments from asymptotic two-scale homogenisation,

- rigorously scale up microscopic systems with compactness and arguments from two-scale convergence,
- determine the quality of certain homogenisation strategies by using information from corrector estimates, and
- numerically illustrate the significance of homogenisation of partial differential equations formulated in perforated domains.

Content
The course covers the following:
(i) scaling and upscaling based on two-scale asymptotics for partial differential equations and systems of equations with oscillating coefficients formulated in perforated domains,
(ii) derivation of explicit formulas for effective coefficients and homogenised elliptic, parabolic, and hyperbolic equations,
(iii) implementation and numerical simulation of homogenised linear elliptic equations,
(iv) derivation of Darcy's law for perforated domains,
(v) introduction to weak convergence for linear elliptic partial differential equations,
(vi) the concepts of two-scale convergence and compactness,
(vii) application of two-scale convergence for homogenisation of second-order linear elliptic equations,
(viii) passage to the homogenisation limit and derivation of corrector estimates.

Reading List
See separate document.

Examination
Assessment is based on an individual written exam and a written hand-in assignment.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

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

Quality Assurance
Follow-up relating to learning conditions and goal-fulfilment 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
The local regulations for studies at the Bachelor and Master levels at Karlstad University stipulate the obligations and rights of students and staff.