FSF3568 Finite Element Methods for Rough Data 7.5 credits

Finita elementmetoden för heterogen data

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

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

Establishment

Course syllabus for FSF3568 valid from Spring 2019

Grading scale

G

Education cycle

Third cycle

Specific prerequisites

This course is designed for PhD students in applied and computational mathematics, but it is suitable also for other PhD students with a background in computation with mathematical interests. The students are expected to have taken basic and a continuation course in numerical analysis or acquired equivalent knowledge in a different way.

Language of instruction

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

Intended learning outcomes

After completion of the course, the students are expected to be able to:

- verify existence and uniqueness of solutions to elliptic partial differential equations and to state the expected regularity of the arising solutions depending on the roughness assumptions on the data
- apply, extend and generalize finite element methods in particular with respect to heterogenous coefficients
- derive a priori error estimates that are sensitive with respect to data-regularity and data-variations
- construct and apply FE-based generalized variational multiscale methods as a tool for stabilizing conventional finite element methods in low-regularity regimes

Course contents

This course is devoted to the finite element method in the context elliptic partial differential equations. We start with recalling the notions of weak solutions in Sobolev spaces, calculus of variations and regularity theory. After that we introduce the concept of Galerkin approximations which we apply to Lagrange finite elements. The arising methods are analyzed in terms of a priori error estimates and numerical stability. Here we have a particular look at low-regularity/multiscale regimes, the issues that we face in these cases and why this has important practical implications. As an approach to overcome these issues we introduce the concept of generalized finite elements which can be used as a tool to stabilize the conventional methods.

Note that this course mainly focuses on analytical aspects of finite elements, whereas its implementation is only discussed briefly. The course does not incorporate programming aspects, as this is typically covered by other courses.

Disposition

Lectures, Homeworks and either individual project or oral exam

Course literature

Regularly updated lecture notes (PDF manuscript);

S. Brenner and R. Scott "The mathematical theory of finite element methods“;

L. Evans "Partial differential equations“

Examination

- INL1 - Assignment, 7.5 credits, grading scale: P, F

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.

The examination will consist of two mandatory elements:

1. homeworks
2. written presentation of the project or oral exam

Other requirements for final grade

Homeworks and projects / oral exam completed.

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.