FDD3375 High Performance Finite Element Modeling 7.5 credits

Högprestandamodellering med finita element

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 FDD3375 valid from Spring 2019

Grading scale

P, F

Education cycle

Third cycle

Specific prerequisites

Language of instruction

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

Intended learning outcomes

The general aim is that the students should understand how one models PDE numerically with FIVE in a general framework in this course FEniCS-HPC, with scalable performance. Concretely, it implies that the students should be able to:
* Derive adaptive finite element methods for general PDE with relevance in the industry: Navier-Stoke's equations for incompressible flow, the wave equation, Navier's elasticity equation and multi-physics combinations of these equations.
* Account for general FEM algorithms as assembling, adaptivity and grid refinements, and have a basic understanding of the implementation in FEniCS-HPC.
* Account for parallel data structures and algorithms for distributed memory in a general FEM framework and check its implementation in FEniCS-HPC: distributed computational net, ghost entities, distributed sparse linear algebra, local grid refinement with bisection for a distributed computational net and general goal based adaptive error handling.
* Use a general framework e g FEniCS-HPC, to model and solve general PDE on a super computer in a project that the student designs alone.

Course contents

Basic natural laws are expressed typically in the form of a PDE. The finite element method (FIVE) has grown up to be a universal tool to calculate solutions of PDE with a lot of applications in technology and science. This is an advanced course that introduces Navier-Stoke's equations as a basic model for fluid mechanics, adaptive finite element methods with residual-based stabilisation to calculate solution approximations including prediction of rough quantities in turbulent flows such as air resistance, and general automatic parallel FEM algorithms in FEniCSHPC. Furthermore, the students will learn other physical phenomena such as elasticity and acoustic waves, and multi-physics combinations of phenomenon by means of the same general methodology. The theoretical parts of the course concern stability analysis of the numerical method, the goal-oriented a posteriori error analysis and scalable distributed data structures and algorithms for the computational net and sparse linear algebra. The course module with computer implementation focuses on FIVE for Navier-Stoke's equations in FEniCSHPC, inspection of parallel performance and application of the methods on super computers.

Examination

- EXA1 - Examination, 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.

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.