FSF3561 The Finite Element Method 7.5 credits

Finita elementmetoden

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 FSF3561 valid from Spring 2019

Grading scale

G

Education cycle

Third cycle

Specific prerequisites

A Master degree including at least 30 university credits (hp) in in Mathematics (Calculus, Linear algebra, Differential equations, numerical analysis).

Language of instruction

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

Intended learning outcomes

Basic laws of nature are typically expressed in the form of partial differential equations (PDE), such as Navier's equations of elasticity, Maxwell's equations of electromagnetics,Navier-Stokes equations of fluid flow, and Schrödinger's equations of quantum mechanics. The Finite element method (FEM) has emerged as a universal tool for the computational solution of PDEs with a multitude of applications in engineering and science. Adaptivity is an important computational technology where the FEM algorithm is automatically tailored to compute a user specified output of interest to a chosen accuracy, to a minimal computational cost.

This FEM course aims to provide the student both with theoretical and practical skills, including the ability to formulate and implement adaptive FEM algorithms for an important family of PDEs.

The theoretical part of this course deals mainly with scalar linear PDE, after which the student will be able to

- derive the weak formulation
- formulate a corresponding FEM approximation;
- estimate the stability of a given linear PDE and it's FEM approximation;
- derive a priori and a posteriori error estimates in the energy norm, the L2-tnorm, andlinear functionals of the solution;
- state and use the Lax-Milgram theorem for a given variational problem.

Having completed the practical part of the course the student will be able to:

- modify an existing FEM program to solve a new scalar PDE (possibly nonlinear);
- implement an adaptive mesh refinement algorithm, based on an a posteriori error estimate derived in the theoretical part;
- describe standard components in FEM algorithms.

Course contents

- FEM-formulation of linear and non-linear partial differential equations, element types and their implementation, grid generation, adaption and error control, efficient Solution algorithms (e.g. by a multigrid method).
- Applications to stationary and transient diffusion processes, elasticity, convectiondiffu sion, Navier-Stokes equation, quantum mechanics etc.

Disposition

Lectures , laboratory exercises

Course literature

To be announced at least 4 weeks before course start at course web page.

Examination

- LAB1 - Laboratory work, 4.5 credits, grading scale: P, F
- TEN1 - Written exam, 3.0 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.

- Advanced Laboratory Work
- Assignments
- Written Examination

Other requirements for final grade

The student must pass all parts of the examination:

- Advanced Laboratory Work
- Assignments
- Written Examination

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.