SF2561 The Finite Element Method 7.5 credits

Finita elementmetoden

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

Establishment

Course syllabus for SF2561 valid from Autumn 2013

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Mathematics, Technology

Specific prerequisites

Single course students: 90 university credits including 45 university credits in Mathematics or Information Technology. English B, or equivalent.

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-norm, and linear 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, convectiondiffusion,
Navier-Stokes equation, quantum mechanics etc

Course literature

To be announced at least 4 weeks before course start at course web page. Previous year:
K. Eriksson, D. Estep, P. Hansbo, C. Johnson: Computational Differential Equations.
Studentlitteratur, ISBN 91-44-49311-8

Examination

- TEN2 - Written Examination, 3.0 credits, grading scale: A, B, C, D, E, FX, F
- LAB2 - Laboratory Work, 4.5 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.

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

- LAB2 - Laboratory Task, 4.5 credits, grade scale: P, F
- TEN2 - Examination, 3.0 credits, grade scale: A, B, C, D, E, FX, F

Other requirements for final grade

- Examination (TEN2; 3 university credits).
- Assignments (LAB2; 4.5 university credits).

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.