Finite Element Methods, 7.5 hp

Course period:
January 20 - March 31, 2020

Last day for application:
January 20, 2020

Course leader / Address for applications:
Axel Målqvist / axel@chalmers.se

Course description (Advertisement for Ph.D. students):
The first part of the course is based on Chapters 0 – 4 and 9 in The Mathematical Theory of Finite Element Methods", written by Brenner and Scott, with emphasis on 3 and 4. In the second part we will consider selected topics from the remaining Chapters as well as other material. In the second part the participants will take an active role in selecting and presenting the material.

In this course we first study how to construct finite element function spaces based on triangular or rectangular element domains and piecewise polynomials. Then we develop the associated approximation theory based on averaged Taylor polynomials and Riesz potentials. This leads to interpolation error estimates in Sobolev norms. We then consider convergence of adaptive schemes. In the second part of the course we focus on applications of the theoretical framework to other equations.
We will meet twice a week during period 3.

Responsible department and other participation departments/organisations:
Mathematics Department

Teacher:
Axel Målqvist

Examiner:
Axel Målqvist

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1. Confirmation
The syllabus was confirmed by the Head of the Department of XXX 200X-XX-XX, 200X-XX-XX.

Disciplinary domain: Science
Department in charge: Department of Mathematical Sciences
Main field of study: Mathematics

2. Position in the educational system
Elective course; third-cycle education

3. Entry requirements
Some experience with partial differential equations, finite element methods, functional analysis, and Sobolev spaces, corresponding to, for example, Chapter 5 and Appendix of S. Larsson and V. Thomée, Partial Differential Equations with Numerical Methods, Texts in Applied Mathematics 45, Springer, 2003.

4. Course content
We will cover important results from the theory of Sobolev spaces, variational formulation of elliptic boundary value problems and the formulation of the finite element method, construction of finite elements, polynomial approximation theory in Sobolev spaces, convergence of adaptive algorithms as well as applications of the theoretical results to other equations.

5. Outcomes

After completion of the course the Ph.D. student is expected to be able to:

- understand the fundamental tools in the analysis of finite element methods.

6. Required reading
S. C. Brenner and L. R. Scott, The mathematical theory of finite element methods, 3rd ed., Springer, 2008.

7. Assessment
Hand in assignments as well as giving a lecture on a topic relevant to the course.

A Ph.D. student who has failed a test twice has the right to change examiners, if it is possible. A written application should be sent to the Department.

In cases where a course has been discontinued or major changes have been made a Ph.D. should be guaranteed at least three examination occasions (including the ordinary examination occasion) during a time of at least one year from the last time the course was given.

8. Grading scale
The grading scale comprises Fail, (U), Pass (G)

9. Course Evaluation
The course evaluation is carried out together with the Ph.D. students at the end of the course, and is followed by an individual, anonymous survey. The results and possible changes in the course will be shared with the students who participated in the evaluation and to those who are beginning the course.

10. Language of instruction
The language of instruction is English.