KTH Matematik

Exam Topics

3561/SF2561The Finite Element Method
Scheduled Exam: **2023-10-26, 8.00-13.00**

Aids: None

Total 50p: 20p for grade E, 25p for grade D, 30p for grade C, 35p for grade B, and 40p for grade A.

The exam will cover both theory and aspects of implementation. For theorems and lemmas, you should understand the concepts behind them and where they are used.

- → The steps to forming a finite element approximation, including calculation of the mass and stiffness matrix as well as the load vector.
- → Differences between the spaces $\mathcal{C}^0(\Omega)$, $\mathcal{H}^1(\Omega)$, $\mathcal{H}^1_0(\Omega)$, $L^2(\Omega)$ as well as their corresponding definitions on the boundary or element (boundaries) as well as inner product and norms (if applicable).
- → Differences between boundary conditions
- → Forming the FEM basis functions
- → Definitions of mesh size, shape regularity, quasi-uniform, hanging node.
- → Required properties of stiffness matrix for a unique solution.
- → Useful inequalities (Cauchy Schwarz, Poincare-Friedrichs, Poincare)
- → Definitions: Galerkin orthogonality, continuity, coercivity, linear/bilinear form
- → Theorems/Lemmas: Lax-Migram theorem, trace theorem, Céa's Lemma,
- → Aubin-Nitche duality
- → Obtaining error estimates (*a priori* and *a posteriori*) and how they are used.
- → Adaptive mesh refinement.
- → Stability of parabolic equations

$\longrightarrow$ Time discretization of parabolic equations with theta-scheme

Implementation aspects for the FEM approximation

- ◇ Computational differences between Trapezoidal rule and other quadratures.
- ◇ Element type
- ◇ Matrix assembly
- ◇ Mapping from reference element to general element
- ◇ Implementation of boundary conditions

Suggested review material

- ◇ Lecture notes from the in class lectures
- ◇ Problem sets
- ◇ Labs
- ◇ Past exams

Note that when reviewing the problem sets and lab exercises, you should think about the motivation behind the behind the question.