

Mathematics of the Finite Element Method:

Essentials for the numerical treatment of elliptic pdes

(La Matematica del metodo degli elementi finiti: fondamenti per il trattamento numerico di problemi ellittici)

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List of topics (draft):

- i. Essential notions on Sobolev spaces (traces in H^1 , dual spaces); variational formulation of the Poisson problem (in dimension > 1) and good position (Lax-Milgram).
- ii. Galerkin method, Cea lemma in the general and symmetric case; various examples of elliptic problems.
- iii. Estimation of the interpolation error: definition of the interpolator; Deny-Lions theorem; related finite elements and reference element, scaling argument; error estimate for the Galerkin method in the Poisson case both in norm H^1 and L^2 (Aubin-Nitsche).
- iv. First Strang lemma and quadrature error analysis for linear elements; Second Strang lemma and analysis of the error of approximation of the domain for linear elements.
- v. Some implementation issues: the structure of a finite element code.
- vi. The diffusion-transport problem with dominant transport: exact solution and numerical difficulties. Description of the "non-conforming artificial-diffusion" (NCAD) and "streamline-upwind Petrov-Galerkin" (SUPG) methods; error analysis for SUPG.
- vii. Stokes Equation: inf-sup condition for the Babuška-Brezzi theorem. Mixed finite element methods.
- viii. Darcy problem: implementation of mixed finite elements RT0-P0.
- ix. Isogeometric method for elliptic problems.
- x. Extensions and open questions.

Schedule of Lectures (To Be Confirmed):

Lecture 1: April 27, from 10 to 12;
Lecture 2: April 30, from 11 to 13;
Lecture 3: May 4, from 11 to 13;
Lecture 4: May 7, from 11 to 13;
Lecture 5: May 11, from 11 to 13;
Lecture 6: May 14, from 11 to 13;
Lecture 7: May 18, from 11 to 13;
Lecture 8: May 21, from 11 to 13;
Lecture 9: May 25, from 11 to 13;
Lecture 10: May 28, from 11 to 13.

How to Register to the Course

Students interested in attending the Course should

- ✓ download MICROSOFT TEAMS (if they have not already done) from the web site

<http://softwaresso.unina.it/teams/>

- ✓ join the Team “Mathematics of the Finite Element Method - PhD course” through the following code

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