MATH 6590, Topics on Applied Mathematics

Finite element methods

MW 4:00–5:15 pm, MATH 428

Instructor Yanqiu Wang

- Office: MATH 441 (405-744-5698)
- Office hours: TTH 4-6 pm or by appointment
- Email: yqwang (AT) math.okstate.edu

Course Description An introduction to the finite element method. We will cover the following contents: Sobolev spaces, weak(variational) formulation, Ritz-Galerkin method, existence and uniqueness of the solution, finite element spaces, error estimates, implementation.

Prerequisites Math 4263 (Introduction to PDEs), Math 5043 & 5053 (Advanced Calculus), Math 5553 (Numerical Linear Algebra), or equivalents. Students should also be familiar with at least one of the following computer programming languages: Matlab, C/C++, Fortran.

Course Contents

1. Introduction to the finite element methods using an example of one-dimensional elliptic boundary value problem. Weak(variational) formulation, natural and essential boundary conditions, Ritz-Galerkin method, 1-d finite element space.
2. General finite element theory. Well-posedness of the discrete system, 2-d and 3-d finite element spaces, non-conforming finite elements, error estimates.
3. Data structure of finite element codes.
4. Finite element methods for time-dependent problems.

Textbook *The mathematical theory of finite element methods* (3rd edition) by Susanne C. Brenner and L. Ridgway Scott.
OSU students have online access to the entire book through the library link.

Additional reading

1. C. Johnson, Numerical solution of partial differential equations by the finite element method, Cambridge University Press, 1987;
2. G. Strang and G.J. Fix, An Analysis of the Finite Element Method, Wellesley-Cambridge Press, 1988;
3. P.G. Ciarlet, The Finite Element Method for Elliptic Problems, North-Holland, Amsterdam, 1979 (also in Classics in Applied Mathematics, Vol 40, SIAM, Philadelphia, 2002);
4. A. Ern and J.-L. Guermond, Theory and Practice of Finite Elements, Springer, 2004.

Grading Policy Your final grade will be based on 5 homework assignments, 20 points each. The total is 100 points. You sacrifice 5 points per day for each late homework assignments. Early submissions are always welcome.