Math 5520: Finite Element Methods I

Spring 2016

Instructor: Jeffrey Connors
Office: MSB 324
e-mail: jeffrey.connors@uconn.edu
phone: (860) 405-9188
webpage

Lectures: MWF 11:15 AM-12:05 PM in MSB 215.

Office hours: MWF 12:05-1:00 PM in MSB 324 or by appointment.

Class web page: www.math.uconn.edu/~connors/math5520s16/index.html
Note: the class web page will serve as a means to disseminate lecture slides and homework during the semester.

Textbook: The lectures will be digitized (for the most part) and will loosely follow the book *Understanding and implementing the finite element method* by Mark Gockenbach (SIAM 2006) for a large part of the semester. The lectures will also contain material from other sources. The book is not required, but it could serve as a guide for programming, if purchased, and also has value for understanding the theory. There is also code that should be exploited, on Gockenbach's FEM website.

Synopsis: This course is appropriate for mathematics students who are interested in applications and numerical analysis, as well as mathematically-inclined students with other backgrounds. The main goals are (1) to provide a rigorous theoretical foundation for the application of the finite element method to approximate the solution of a (well-posed) partial differential equation and (2) to provide experience in coding the finite element method and verifying the correctness of the code. The course will draw upon results in linear algebra, real analysis, partial differential equations and some functional analysis on Hilbert spaces to analyze the properties of finite element approximations. The theoretical results will be illustrated by coding up examples in MatLab.

Topics (covered to various depths):

- FEM for two-point boundary value problems
- Some introduction to Sobolev spaces
- FEM for elliptic equations
- Approximation theory for FEM
- Non-conforming and mixed FEM
- FEM for parabolic equations
- FEM for advection-diffusion equations
- FEM for hyperbolic equations
- Some nonlinear equations
- Some introduction to numerical error calculations (*a posteriori*)

Homework: Homework will be assigned bi-weekly (roughly) with both theoretical and computational components. The coding platform for this course is MATLAB. Code may be written in other programming languages with the consent of the instructor. Again, there is code associated with the book that may be exploited, but it is MATLAB code.

Grading: There will be a final project that will count for 25% of the final grade. Homework will account for the other 75%.

References:

- *Understanding and implementing the finite element method*, Mark Gockenbach, SIAM, 2006.
- *The mathematical theory of finite element methods*, S. C. Brenner and L. R. Scott, Springer, 1994.
- *The finite element method for elliptic problems*, P. Ciarlet, SIAM, 2002.
- *Partial differential equations with numerical methods*, S. Larsson and V. Thomée, Springer, 2003.
- *Finite element solution of boundary value problems*, O. Axelsson and V. A. Barker, SIAM, 2001.
- *Finite elements: an introduction to the method and error estimation*, I. Babuška, J. R. Whiteman and T. Strouboulis, Oxford University Press, 2011.