# Math 5521: Finite Element Methods II

## Spring 2018

**Instructor:** Jeffrey Connors
Office: MONT 230
e-mail: jeffrey.connors@uconn.edu
phone: (860) 486-9153
webpage: www.math.uconn.edu/~connors

**Lectures:** MWF 1:25-2:15 PM in MONT 101.

**Office hours:** Open door policy. I will always be available after class Monday and Wednesday, but you are welcome to try to stop in any time. Otherwise, email me and we'll set up a specific time to meet.

**Class web page:**
`http://www.math.uconn.edu/~connors/math5521s18/index.html`
Note: the class web page will serve as a means to disseminate course materials during the semester.

**Textbook:** None; see references below.

**Synopsis:** This course builds upon MATH 5520 by providing introductions to mixed, hybrid and discontinuous-Galerkin (DG) finite element methods. Flow in porous media will serve as an application to motivate canonical mathematical models. We develop various discretizations, stability and convergence properties, algebraic systems and comparisons of methods. The focus will remain on elliptic problems, with some brief coverage of (stationary) hyperbolic problems.

**Homework:** Anticipate four written homework assignments. These will be posted on the course webpage.

**Computation:** There will be one computational project regarding mixed FEM and another regarding DG methods. We will use FreeFEM++, which is available for free online and already provides support for the required methods.

**Grading:** Each of the two computational projects is worth 20% of the course grade. Homework will account for the other 60%.

**Some topics:**

- Porous media flow

- Mixed primal and dual formulations

- Saddle-point problems

- Raviart-Thomas elements

- Brezzi-Douglas-Marini elements

- Hybrid methods

- Convection in porous media

- Broken Sobolev spaces

- Upwind Galerkin methods

- Penalty Galerkin methods

- Local DG

**Some references:**

- *The Mathematical Theory of Finite Element Methods*, S. Brenner and L. R. Scott, Springer, 2008.

- *Mixed and Hybrid Finite Element Methods*, F. Brezzi and M. Fortin, Springer, 1991. (There is a new version too).

- *The Finite Element Method: Theory, Implementation and Applications*, M. Larson and F. Bengzon, Springer, 2013.

- *Non-Homogeneous Boundary Value Problems and Applications*, J.-L. Lions and E. Magenes, Springer, 1972.

- *Elliptic Problems in Nonsmooth Domains*, P. Grisvard, SIAM, 2011.

- *Discontinuous Galerkin Methods for Solving Elliptic and Parabolic Equations*, B. Rivière, SIAM, 2008.

- *Numerical Approximation of Partial Differential Equations*, A. Quarteroni and A. Valli, Springer, 1997.

- Various papers.