MTH 655/Numerical Analysis, Winter 2011

http://www.math.oregonstate.edu/∼mpesz/655_W11

NUMERICAL FUNCTIONAL ANALYSIS AND APPLICATIONS

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Class: MWF 11:00-11:50, CRN: 36197 (MTH 655)/ 37728 (MTH 659)

Do you have interest in foundations of numerical analysis such as interpolation and approximation theory ? Do you want to learn how to solve numerically differential equations with singularities and/or on irregular domains and/or want to go beyond finite differences ? Or, you already know classical finite elements for second order elliptic problems, but want to know more ? Or perhaps need to estimate numerical errors or deal with uncertain data ?

This class will cover a variety of applications of numerical functional analysis and in particular selected topics from the Finite Element (FE) method. The course is intended for graduate students of mathematics and various science and engineering disciplines who have some course or project experience with numerical analysis/scientific computing, or those who want to explore selected applied functional analysis topics in the numerical setting.

We will first give a compact introduction/review of Galerkin FE method for approximation of variational solutions to boundary value problems. Next, we will discuss i) mixed and hybrid FE, error estimates and estimators in various norms and quantities of interest, ii) develop methods suitable in optimization, eigenvalue problems, and integral equations, and iii) lead an excursion into stochastic FE and iv) motivate the underlying physical models from fluid and solid mechanics. The class will provide mathematical details; the templates of the algorithms used in exercises will be made available to the students. The assignments will be a mixture of analysis and computations.

This breadth of topics will require not much more than solid real variables, differential equations, and linear algebra background, plus basic computing skills; the stochastic part will require familiarity with probability concepts. Questions concerning pre-requisites should be addressed to the instructor.

Textbook: most topics are covered in Atkinson/Han "Theoretical Numerical Analysis, A Functional Analysis Framework" (Springer, 2000). You can supplement the FE material with one of several excellent textbooks on FE including those by Braess, Bangerth/Rannacher, Becker/Carey/Oden, Brenner/Scott, Ciarlet, Johnson, and many others. [If you have one already, you do not need a new one, but if you have none, I can suggest one based on your background].

MTH 654-656 Sequence: This course is the second in a year-long sequence, and the courses in this sequence can be taken independently.