UNIVERSITY OF Cincinnati

Mathematical Sciences
P.O. Box 210025
Cincinnati, OH 45221-0025

Advanced Numerical Analysis
(Autumn 2013 – MATH-8010 – 907588)

Time and Place:	MWF 11:15 AM – 12:10 PM (60W CHARL 115).
Instructor:	Donald A. French (5420 French Hall).
Phone/Email:	556-4039 & french@ucmail.uc.edu.
Office Hours:	MW 2:30-4:00 PM and by appointment.
Webpage:	http://homepages.uc.edu/∼french/

Prerequisites: Calculus I-III, Differential Equations, Linear Algebra, programming (MATLAB is best here) and some familiarity/experience with partial differential equations as well as numerical analysis (PDE & FA MATH 6007 and MATH 6006 would be best here). Students should have strong mathematics skills and be comfortable with analysis – a focus of this course is on the "why's".

Description: Partial differential equations (PDEs) model a wide range of physical phenomena including heat conduction, wave propagation, and fluid flow. Computer approximations to the solutions of the PDE problems that arise in these applications are usually required. A knowledge of the accuracy, stability and robustness of computational methods is beneficial in understanding the schemes and developing both new discretization procedures and enhancing existing ones.

We will focus on the finite element method (FEM) in this course which is intended for graduate students in Engineering, Physics, Chemistry and Mathematics who are interested in the analysis and development of error estimates. We shall study the use of energy (Hilbert space) techniques.

Initially, we will discuss the mathematical foundations of the FEM in Sobolev spaces and develop a basic approximation theory. Once this background is established, we will survey related topics. These may include applications of the FEM to first order hyperbolic equations or nonlinear time-dependent parabolic problems including the Cahn-Hilliard (phase transitions) or the Navier-Stokes (fluid flow) equations. We may look at discontinuous Galerkin discretizations in time *and space*. Nonconforming methods are also of interest as well as the development of *a posteriori* error estimates and how they are used to design adaptive schemes.

Grading: There will be two in-class exams and a final that count toward most of the course grade.

Midterm I: Friday, October 4 (In Class)
Midterm II: Friday, November 8 (In Class)
Final: Friday, December 13, 1:30–3:30 PM.

Homework assignments will also count and will be given every 1-2 weeks. Late homework may not be accepted or be subject to point reductions. Tentatively, homework will count 40% of the grade, the midterms will be 15% each and the comprehensive final will account for the remaining 30%.

In general, overall scores will converted to letter grades according to A: 94% or higher, A-: 90%-93.9%, B+: 88%-89.9%, B: 84%-87.9%, B-: 80%-83.9%, etc.

Last Day to Withdraw – November 1, 2013. In case a withdrawal shall occur, the instructor will be required to verify whether or not you minimally participated in the class. Although the instructor will try his best to respond accurately, however, in the absence of any evidence to the contrary, the instructor will have to verify that you did not minimally participate. Ways for you to provide clear evidence of your presence in the class include taking at least one quiz and taking the midterm exam.

Relevant References:

1. Computational Differential Equations by K. Eriksson, D. Estep, P. Hansbo, and C. Johnson, Cambridge University Press (1996).

2. Numerical Solutions of Partial Differential Equations by the Finite Element Method by Claus Johnson, Cambridge University Press (1987).

3. Finite Element Methods for Viscous Incompressible Flows by M. D. Gunzburger, Academic Press (1989).

4. Theoretical Numerical Analysis – A Functional Analysis Framework by K. Atkinson and W. Han, Springer (2005).

5. The Mathematical Theory of Finite Element Methods (3rd Ed) by S.C. Brenner and L. R. Scott, Springer (2008).

Academic Integrity Policy: The University Rules, including the Student Code of Conduct, and other documented policies of the department, college, and university related to academic integrity will be enforced. Any violation of these regulations, including acts of plagiarism or cheating, will be dealt with on an individual basis according to the severity of the misconduct.

Special Needs Policy: If you have any special needs related to your participation in this course, including identified visual impairment, hearing impairment, physical impairment, communication disorder, and/or specific learning disability that may influence your performance in this course, you should meet with the instructor to arrange for reasonable provisions to ensure an equitable opportunity to meet all the requirements of this course. At the discretion of the instructor, some accommodations may require prior approval by Disability Services.