Course Outline for MATH 5651, Numerical Analysis

MATH 5651 Numerical Analysis (3 units)
Prerequisite: Graduate standing; or CSC 101 or CSC 1001, and one of the following: AERO 300, AERO 3300, MATH 344, or MATH 3351.

Introduction to advanced numerical analysis. Numerical techniques for solving ordinary and partial differential equations, error analysis, stability, and methods for linear systems. 3 lectures. Formerly MATH 502.

Course Learning Objectives	
1	Compute the order of accuracy of numerical schemes
2	Analyze the stability of numerical schemes
3	Justify the choice of numerical method to solve given ordinary and partial differential equations
4	Implement state-of-the-art numerical methods using an industry-standard programming language
5	Derive numerical schemes accurate to a specified local truncation error for the solutions to given ordinary or partial differential equations
6	Analyze the effectiveness of standard techniques for solving linear systems of differential equations

Expanded Course Content

Textbooks, materials, and/or other resources
1. Arieh Iserles, A First Course in Numerical Analysis of Differential Equations, Cambridge University Press, 1996 2. Lloyd Trefethen, Spectral Methods in Matlab, SIAM 3. Kendall Atkinson, An Introduction to Numerical Analysis, Wiley

Week	Readings	Topics of Discussion
1	Iserles, Chapter 1	Basic finite difference methods for ordinary differential equations
2	Iserles, Chapter 2	Multistep methods; Adams method, backward differentiation
3	Iserles, Chapter 3	Runge-Kutta methods
4	Iserles, Chapter 4	Stiff ordinary differential equations and A-stability

Week	Readings	Topics of Discussion
5	Iserles, Chapter 7	Finite difference schemes for elliptic partial differential equations
6	Iserles, Chapter 9	Gaussian elimination for sparse linear equations
7	Iserles, Chapter 10	Iterative methods for sparse linear equations
8	Iserles, Chapter 11	Multigrid techniques
9	Iserles, Chapter 13	Numerical methods for parabolic partial differential equations
10	Iserles, Chapter 14	Numerical methods for hyperbolic partial differential equations
11	Trefethen, Chapter 1	Differentiation matrices
12	Trefethen, Chapter 2	Semi-discrete Fourier transform
13	Trefethen, Chapter 3	The discrete Fourier transform and the FFT (fast-Fourier-transform)
14	Trefethen, Chapter 4	Smoothness and spectral accuracy
15	Trefethen, Chapter 5	Polynomial interpolation and clustered grids

Method of Assessment

The possible methods of assessment are written individual examinations, quizzes, in-class worksheets and presentations, projects, and homework. One or more midterms and a cumulative final exam are required.

Instructional Mode

The instructional mode for this class is face-to-face. This designation means that the essential academic standards of the course require in-class student engagement, and thus remote instruction is not appropriate.