NUMERICAL ANALYSIS I

MATH 8500

<u>Course Description</u>:

Topics covered in this course include error propagation, solutions of nonlinear equations, solutions of linear and nonlinear systems by various schemes, matrix norms and conditioning, and computation of eigenvalues and eigenvectors. **3 credits**

<u>Prerequisites</u>:

MATH 1960 and MATH 2050, or permission of instructor. Familiarity with computer programming is assumed.

<u>Overview of Content and Purpose of the Course</u>:

This course emphasizes the development of numerical methods to provide solutions to common problems formulated in science and engineering.

This course covers methods for numerically solving problems such as nonlinear equations and nonlinear systems of equations, systems of linear equations by various schemes (direct and iterative methods), computing eigenvalues and eigenvectors, Matrix norms, conditioning of a problem, the propagation of errors, analysis of round-off error, numerical stability for algorithms are included.

<u>Anticipated Audience/Demand</u>:

Graduate students in Mathematics, Engineering, or Computer Science needing advanced numerical methods for solving large problems in linear algebra.

<u>Major Topics</u>:

<u>General Error and Algorithm Considerations</u>:

1) Types of Errors: Rounding, Truncation, Loss of Significance
2) Analysis of Algorithms and Errors, Computational Efficiency
3) Comparison of Different Algorithms for Performing a Task
4) Propagation of Errors- Conditioning and Stability

<u>Nonlinear equations</u>:

1) Convergence of Sequences

2) Scalar Equations
- **a.** Bisection Method
- **b.** Fixed-Point Iteration
- **c.** Newton's Method
- **d.** Other Methods: Secant Method and Muller Method
- **e.** Acceleration Techniques
- **f.** Error Analysis of Fixed-Point Iterations

3) Systems of Nonlinear Equations
- **a.** Fixed-Point Iteration
- **b.** Jacobi and Seidel
- **c.** Newton's Method
- **d.** Quasi-Newton and Steepest Descent Methods

<u>Solution of Linear Systems</u>:

1) Review: Vectors, Matrices, Determinant, Norms, etc.

2) Direct Methods
- **a.** Gaussian Elimination
- **b.** Gaussian Elimination with Pivoting
- **c.** LU Factorization
- **d.** Cholesky Factorization
- **e.** Factorization of Tridiagonal Matrices
- **f.** Error Analysis

3) Iterative Methods
- **a.** Eigenvalues and Eigenvectors
- **b.** Jacobi's Method
- **c.** Gauss Seidel
- **d.** Relaxation Methods
- **f.** Convergence Analysis

<u>Solution of Eigenvalue Problems</u>:

1) Review of Eigenvalue Problem
2) Power and Inverse Power Methods
3) Houselholder Transformation
4) QR Factorization
5) QR Algorithm

<u>Methods</u>:

The course will be presented in a lecture-discussion format.

<u>Student Role</u>:

Students must attend and participate in class in addition to completing course requirements.

<u>Textbook</u>:

Kincaid, David and E. Ward Cheney. *Numerical Analysis: Mathematics of Scientific Computing, 3rd ed.* Kentucky: Brooks/Cole, 2002.

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