NUMERICAL METHODS

MATH/CSCI 3300/8305

Course Description:

This course involves solving equations and systems of equations, interpolation, numerical differentiation and integration, numerical solutions to ordinary differential equations, numerical calculations of eigenvalues and eigenvectors, analysis of algorithms and errors, and computational efficiency. **3 credits**

Prerequisites:

MATH 1960 with a C- or better, MATH 2050 with a C- or better, and MATH 2350 with a C- or better, or permission of instructor.

Overview of content and purpose of the course:

The purpose of this course is to introduce students to the techniques for finding numerical approximations to solutions to mathematical problems of various types.

Anticipated audience/demand:

Graduates and undergraduates needing a basic familiarity with numerical techniques for solving problems.

Major topics:

1) Algorithm and Error Analysis

a. Comparison of Different Algorithms for Performing a Task.

b. Errors
- **1.** Types of Errors
  - **a.** Rounding
  - **b.** Truncation
  - **c.** Loss of Significance
- **2.** Accumulation of Errors-Stability

2) Solutions to Equations, Systems of Equations

a. Two-Point Methods-Single Equations
- **1.** Method of False Position
- **2.** Secant Method
- **3.** Bisection Method

b. One-Point Methods
- **1**. Successive Substitution (Fixed Point Iteration)
- **2.** Successive Substitution with Acceleration

3. Newton’s Method
4. Convergence Criteria

c. Systems of Linear Equations
1. Gaussian Elimination; Choice of Pivots
2. Gauss-Seidel: Convergence

3) Interpolation and Polynomial Approximation

a. Lagrange Interpolation

b. Finite Difference Interpolation with Equal Intervals
1. Forward and Backward Difference Formulas
2. Central difference formulas

c. Divided Difference Methods

d. Comparison of Methods

e. Interpolation Errors

4) Numerical Differentiation, Integration

a. Derivative, Integral Approximations from Interpolation Formulas

b. Extrapolation to the Limit

c. Gaussian Quadrature

d. Romberg Integration

5) Differential Equations

a. Euler's Method

b. Runge-Kutta Methods

c. Multi-Step Methods

d. Predictor-Corrector Methods

e. Analysis of Stability, Errors

6) Numerical Calculation of Eigenvalues, Eigenvectors

a. Power Method

b. Householder's Method

Methods:

This course will be presented by lecture and discussion, along with computer implementation of algorithms. Maple will be used as a tool for analyzing problems.

Student Role:

Students must attend lectures, participate in discussions, and complete the written homework and programming assignments.

Textbook:

Faires, J. Douglas, and Richard L. Burden. *Numerical Methods, 4th ed*. Boston: Brooks/Cole, 2012.

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