NUMERICAL METHODS
MATH 3300/8305

1.0 Course Objectives

1.1 Overview of Content and Purpose: (3 hours) 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, computational efficiency.

1.2 For whom: Graduates and undergraduates needing a basic familiarity with numerical techniques for solving problems.

1.3 Prerequisites: MATH 1960 AND MATH 2050

1.4 Unusual Circumstances: None

2.0 Objectives

2.1 Performance Objectives for The students: The purpose of this course is to introduce the student to:

1. Techniques for finding numerical approximations to solutions to mathematical problems of various types.
2. Considerations of algorithm efficiency and error control in numerical procedures.
3. The use of packaged computer algorithms in the solution of numerical problems.

3.0 Content and Organization

3.1 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. Regula falsi
     2. Secant Method
     3. Successive bisection
   - b. One-point methods
     1. Successive substitution (fixed pint iteration)
     2. Successive substitution with acceleration
     3. Newton’s Method
     4. Convergence criteria
   - c. Systems of Linear Equations
     1. Guassian elimination; choice of pivots
     2. Gauss-Seidel: convergence

3) Interpolation
   - 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. Errors

4) Numerical differentiation, integration
   - a. Derivative, integral approximations from interpolation formulas
   - b. Extrapolation to the limit
   - c. Gaussian quadrature
   - d. Approximation of partial derivatives, multiple integrals
   - e. Romberg Integration

5) Differential equations
   - a. Runge-Kutta methods
   - b. Multi-step methods
   - c. Predictor-corrector methods
   - d. Analysis of stability, errors

6) Numerical calculation of eigenvalues, eigenvectors
   - a. Power Method
   - b. Deflation

4.0 Teaching Methodology

4.1 Methods to be Used: Primarily lecture and discussion, although work with computer implementations of algorithms will provide an important body of experience.

5.0 Evaluation

5.1 Basis for Evaluating Student Performance: Evaluation will be based on examination results, homework (both hand problems and solutions using available computer routines), and original computer projects. Graduate students will be given assignments involving work not expected of undergraduate students.

5.2 Basis for Determining Final grade:

6.0 Resource Material

6.1 Textbook(s) Or other Required Readings: Burdon, *Numerical Analysis*, Brooks Cole, ISBN 0534382169