OFFICIAL SYLLABUS

465 – Numerical Analysis

Adopted – Fall 2011 (Committee: Drs. Lu, Leem, Pelekanos, Sewell)

Catalog Description : Error analysis, solution of nonlinear equations, interpolation, numerical differentiation and integration, numerical solution of ordinary differential equations, solution of linear systems of equations.

Prerequisite: Math 250, 305, CS 140 or 141

(Prerequisite change has been requested and is pending (CAS #14-86). After the change is approved, the prerequisite will be MATH 223, 305, and CS 145 with a grade of C or better or consent of instructor.)

Textbook: Numerical Analysis, 9th Edition by Burden and Faires

Course Outline and Topics

Chapter 1. Mathematical Preliminaries and Error Analysis
1.2 Round-off Errors and Computer Arithmetic
1.3 Algorithms and Convergence

Chapter 2. Solutions of Equations in One Variable
2.1 The Bisection Method
2.2 Fixed-Point Iteration
2.3 Newton's Method and Its Extensions
2.4 Error Analysis for Iterative Methods
2.5 Accelerating Convergence

Chapter 3. Interpolation and Polynomial Approximation
3.1 Interpolation and the Lagrange Polynomial
3.3 Divided Differences
3.4 Hermite Interpolation
3.5 Cubic Spline Interpolation

Chapter 4. Numerical Differentiation and Integration
4.1 Numerical Differentiation
4.2 Richardson's Extrapolation
4.3 Elements of Numerical Integration
4.4 Composite Numerical Integration
4.5 Romberg Integration
4.6 Adaptive Quadrature Methods
4.7 Gaussian Quadrature

Chapter 5. Initial-Value Problems for Ordinary Differential Equations
5.1 The Elementary Theory of Initial-Value Problems **(Brief Review)**

5.2 Euler's Method
5.3 Higher-Order Taylor Methods
5.4 Runge-Kutta Methods
5.6 Multistep Methods
5.7 Variable Step-Size Multistep Methods

Chapter 6. Direct Methods for Solving Linear Systems
6.1 Linear Systems of Equations **(Optional)**
6.2 Pivoting Strategies **(Optional)**

Learning Objectives

The primary goal is to provide students with a basic knowledge of numerical methods including: root-finding, interpolation, numerical differentiation and integration, and numerical solution to ordinary differential equations. MATLAB is the software environment used for implementation and application of these numerical methods. The numerical techniques learned in this course enable students to work with mathematical models of technology and systems.

Objective 1

Understand the implications of digital number representation and digital arithmetic for computational science and engineering.

- Outcome 1.1: Understand the fundamental principles of digital computing, including number representation and arithmetic operations.
- Outcome 1.2: Understand the linkage between accuracy, stability and convergence.
- Outcome 1.3: Perform error analysis for arithmetic operations.
- Outcome 1.4: Understand the propagation of errors through complex numerical algorithms.
- Outcome 1.5: Perform numerical stability analysis.

Objective 2

Develop and implement numerically stable and accurate algorithms for all the basic tasks of computational science and engineering:

- Outcome 2.1: Develop efficient and stable algorithms for finding roots of non-linear equations.
- Outcome 2.2: Develop robust and stable algorithms for numerical differentiation and integration.
- Outcome 2.3: Understand the use of interpolation for numerical differentiation and integration as well as in function approximation.
- Outcome 2.4: Develop stable solution algorithms for ordinary differential equations.