NUMERICAL ANALYSIS
MA531

1. Course Description

Topics include iterative methods of solving equations; interpolation and polynomial approximation; numerical differentiation and integration; numerical solution of differential equations; solution of linear systems by direct and iterative methods; matrix inversion and calculation of eigenvalues and eigenvectors of matrices. Selected algorithms may be programmed.

2. Goals of the Course

a. To strengthen the students' grasp of basic notions in analysis and algebra, e.g., the idea of a sequence, limit recursion relation, definite integral, matrix techniques in algebra.
b. To help the student see the connection between an algorithm as a computational procedure, and the mathematical foundations.
c. To help the student appreciate the type of algorithmic approach that enables a problem to be handled by a computer.

3. Instructional Procedure

a. Lecture/discussion
b. Small group study
c. Use of computer software/write computer algorithms by FORTRAN or C

4. Course Content

I. Number Systems and Errors
   a. The Representation of Integers
   b. The Representation of Fractions
   c. Floating-point Arithmetic
   d. Computational Methods for Error Estimation

II. Interpolation by Polynomial
   a. Polynomial Forms
   b. Existence and Uniqueness of the Interpolating Polynomial
   c. The Divided-Difference Table
   d. Interpolation at an Increasing Number of Interpolation Points
   e. The Error of the Interpolating Polynomial

III. The Solution of Nonlinear Equations
   a. A Survey of Iterative Methods
   b. Fortran Programs for Some Iterative Methods
   c. Fixed-point Iteration
   d. Convergence Acceleration for Fixed-point Iteration
   e. Quadratic Convergence and Newton's Method
   f. Polynomial Equations: Real Roots

IV. Differentiation and Integration
   a. Numerical Differentiation
   b. Numerical Integration: Some Basic Rules
   c. Numerical Integration: Gaussian Rules
   d. Numerical Integration: Composite Rules

V. The Solution of Differential Equations
   a. Simple Difference Equations
   b. Numerical Integration by Taylor Series
   c. Error Estimates and Convergence of Euler's Method
   d. Runge-Kuta Methods

5. Evaluation Measures for Determining students' Grades

Total points is 100. The component is the following:

Homework	25%
Computer projects	25%
Midterm exam	25%
Final exam	25%
Minimum passing	60%

All programs submitted for grading must be suitably documented showing both input and output along with a complete listing of the program. No late assignments will be accepted without the permission of the instructor. The midterm and the final exam are scheduled to be given.

6. Bibliography

I. Required Text

a. ELEMENTARY NUMERICAL ANALYSIS: An Algorithmic Approach, 3rd Edition by
   Conte and de Boor, published by McGraw-Hill Book Company, 1980
b. NUMERICAL ANALYSIS, 6th Edition, by Richard L. Burden and J. Douglas
   Faires, published by Brooks/Cole Publishing Company, 1997
c. NUMERICAL ANALYSIS, by Johnson, L., and R. D. Riess, Publishing Company Addison-Wesley, Read, Mass., 1997

II. Supporting Bibliography

a. The **C** programming language, 2nd Edition, by Kernighan and Ritchie, published by Prentice Hall Inc., 1988
b. Learning **C**, by Neill Graham, published by McGraw-Hill, Inc., 1992
c. Analytical, Numerical, and computational methods for science and engineering, by Gene H. Hostetter, Mohammed S. Santine, and Paul D'Carpio-Montalvo, published by Prentice Hall, 1991

d. Numerical methods for differential equations: Fundamental Concepts for Scientific and Engineering Applications, by Michael A. Celia and William G.Gray, published by Prentice Hall, 1992

e. Numerical methods for science and engineering, 2nd Edition, by Hamming, R. W., published by McGraw-Hill, Inc., New York, 1973