I. TITLE OF COURSE, COURSE NUMBER and CREDITS
“Numerical Methods“, CS402, Credits: 3

II. DESCRIPTION OF THE COURSE:
An introduction course in numerical methods, theory and application. Emphasizes building algorithms for solution of numerical problems, the sensitivity of these algorithms to numerical errors and efficiency of these algorithm. Topics include: solutions to non-linear equations; system of linear equations, interpolation, polynomial approximations, and quadrature solutions; numerical differentiations and integrations, eigenvalues and eigenvectors.

III. COURSE PRE-REQUISITE: CS260 and Math 161 with grades of C- or better in both

IV. OBJECTIVES OF THE COURSE:
1. To learn topics in basis numerical analysis and methods used to solve physical problems
2. To hone students’ programming skill using appropriate programming language(s)
3. To further develop concepts and theories in analysis and construct of algorithms
4. To sharpen students’ problem solving techniques as well as their analytical and intellectual thought processes

V. STUDENT LEARNING OUTCOMES:
Upon completion of the course, students will be able to:
1. Acquire basic knowledge in theory and application of numerical methods used to solve physical problems. Measure: exams, surveys, and projects.
2. Gain advanced programming skills in the appropriate programming language(s). Measure: exams and projects.
3. Enhance their ability in analysis and construct of algorithms related to numerical methods. Measure: exams and projects.
5. Strengthen their ability to present material both in oral and written form via homework and project participation. Measure: exams, homework and projects.

VI TOPICAL OUTLINE OF THE COURSE CONTENT:

Topic 1: Reviews of programming and mathematical background

Topic 2: Number Representation and Error Analysis:
- Representation of Numbers in Different Bases
- Floating-Point Number System
- Loss of Significance

**Topic 3:** Solutions of Non-linear Equations: Theory and algorithm construct and Programming Implementation of:
- Simple iterations, Bisection Method, Newton’s Method, Secant method
- Fixed Point Iteration

**Topic 4:** Interpolation and Polynomial Approximation: Theory, algorithm construct and programming Implementation of:
- Polynomial Interpolation: Newton’s Interpolating Polynomial, Lagrange Interpolating Polynomial
- Error Analysis in Polynomial Interpolation

**Topic 5:** System of Linear equations: Theory, algorithm construct and programming implementation of:
- Gaussian Elimination, Gauss-Jordan, LU Factorization Tri-diagonal and Other Band Systems, Iterative Solution, Gauss-Seidel Iteration Method, Pathological Conditions, Determinants, Norms and Convergence, Inversion of Matrices, Eigenvalues and Eigenvectors, and Error Analysis

**Topic 6:** Numerical Differentiation: Theory, Algorithm Constructs and Programming Implementation of:
- Difference Formulas, First Derivative Formula via Taylor Series,
- Richardson Extrapolation, Second-Derivatives via Taylor Series, Formulas for Higher-Order Derivatives, Lozenge Diagrams, Error Analysis

**Topic 7:** Numerical Integration: Theory, Algorithm Construct and Programming Implementation of:
- Definite Integral, Reimann’s Theorem, Newton Cote’s Formulas,
- Trapezoidal Rule, Romberg Algorithm, Simpson’s Rules,
- Gaussian Quadrature Formulas

**VII**  **GUIDELINE/SUGGESTIONS FOR TEACHING METHODS AND STUDENT LEARNING ACTIVITIES:**

1. Lectures and problem solving sessions
2. Homework presentation both in written and oral forms
3. Computer programming projects both in individual and group set-up

**VIII** **GUIDELINES/SUGGESTIONS FOR METHODS OF STUDENT ASSESSMENT:**

1. Class attendance required
2. Classroom participation heavily counted
3. Scheduled Classroom exams and quizzes
4. Homework assignments
5. Programming Assignments with strict deadline. Individual effort required
6. Project presentation
7. Always accord respect to others and conduct professionally

IX SUGGESTED READING, TEXT, OBJECTS OF STUDY:


Appropriate programming language(s)

X BIBIOGRAPHY OF SUPPORTING TEXTS AND OTHER MATERIALS:


XI PREPARER’S NAME AND DATE: Dr. John Najarian; Fall 1996

XII ORIGINAL DEPARTMENTAL APPROVAL DATE: Spring 1997

XIII REVISORS’ NAMES AND DATES:
Dr. E. Hu; Spring 2000 and Dr. Li-hsiang (Aria) S. Cheo; Fall 2000; second revision in Spring 2005

XIV DEPARTMENTAL REVISION APPROVAL DATE: Spring 2005