

CORE PAPER-VIII
NUMERICAL METHODS AND SCIENTIFIC COMPUTING

Use of Scientific Calculator is allowed.

Objective: Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of systems of linear equations and differential equations, interpolation, differentiation, evaluating integration.

Expected Outcome: Students can handle physical problems to find an approximate solution. After getting trained a student can opt for advance courses in numerical analysis in higher mathematics. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.

UNIT-I

Rate of convergence, Algorithms, Errors: Relative, Absolute, Round off, Truncation. Approximations in Scientific computing, Error propagation and amplification, conditioning, stability and accuracy, computer arithmetic mathematical software and libraries, visualisation,

Numerical solution of non-linear equations: Bisection method, Regula- Falsi method, Secant method, Newton- Raphson method, Fixed-point Iteration method.

UNIT-II

Rate of convergence of the above methods. System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. Computing eigen-values and eigenvectors

UNIT-III

Polynomial interpolation: Existence uniqueness of interpolating polynomials. Lagrange and Newtons divided difference interpolation, Error in interpolation, Central difference & averaging operators, Gauss-forward and backward difference interpolation. Hermite and Spline interpolation, piecewise polynomial interpolation.

UNIT-IV

Numerical Integration: Some simple quadrature rules, Newton-Cotes rules, Trapezoidal rule, Simpsons rule, Simpsons $3/8^{th}$ rule, Numerical differentiation and integration, Chebyshev differentiation and FFT, Richardson extrapolation.

(ii) Simpson's rule.

Note: For any of the CAS *Matlab / Mathematica / Maple / Maxima* etc., Data types- simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expression, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

BOOKS RECOMMENDED:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering Computation*, New age International Publisher, India,
2. Michael Heath: *Scientific Computing : An introductory Survey*.

BOOK FOR REFERENCES:

1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. Kendall E. Atkinson: *An Introduction to Numerical Analysis*
3. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 7th Edition, 2008
4. S. D. Conte & S. de Boor: *Elementary Numerical Analysis: An Algorithmic Approach*.