

**Department of Civil Engineering
M. Tech. (Structural Engineering)**

Numerical Methods for Structural Engineering

Course Code: NMA 551

L-T-P-C: 3-1-0-4

Course Outcomes: At the end of this course, the students are expected to:

CO 1	Apply direct and iterative methods to solve systems of linear equations and determine eigenvalues and eigenvectors for structural engineering problems
CO 2	Utilize various interpolation techniques, including Lagrange and Hermite methods, to approximate functions in structural analysis
CO 3	Employ finite difference methods to derive differentiation formulas and solve boundary value problems for beams, columns, and rectangular plates
CO 4	Implement numerical differentiation and integration techniques, such as Simpson's rule and Newmark's method, to calculate slopes and deflections in beams
CO 5	Solve ordinary differential equations using methods like Euler's and Taylor's series, with applications to simple harmonic motions in structural dynamics

Unit 1

Solutions of linear equations: Direct method, Cramer's rule, **Gauss** Elimination method- Gauss Jordan elimination, Triangulation (LU Decomposition) method, Iterative methods Jacobi Iteration method, Gauss Siedel iteration, Successive over, relaxation method, Eigen values and eigen vectors: Jacobi method for symmetric matrices, Given's method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method of arbitrary matrices, Power method.

Unit 2

Interpolation: Linear Interpolation, Higher order Interpolation, Lagrange Interpolation, Interpolating polynomials using finites differences, Hermite Interpolation, piecewise and spline Interpolation.

Unit 3

Finite Difference and their Applications: Introduction, Differentiation formulas by Interpolating parabolas, Backward and forward and central differences, Derivation of Differentiation formulas using Taylor series, Boundary conditions, Beam deflection, Solution of characteristic value problems, Numerical solution to spatial differential equations, Application to Simply Supported Beams, Columns & rectangular Plates.

Unit 4

Numerical Differentiation: Difference methods based on undetermined coefficients- optimum choice of step length– Partial differentiation. Numerical Integration: Method based on interpolation-method based on undetermined coefficient Gauss Lagrange interpolation method, Double integration using Trapezoidal and Simpson's method, Newmark's Method and Application to Beams, Calculations of Slopes & Deflections.

Unit 5

Ordinary Differential Equation: Euler's method, Backward Euler method, Midpoint method, single step method, Taylor's series method- Boundary value problems, Initial Value problems. Applications to simple harmonic motions.

Textbooks

1. Numerical Methods for Scientific and Engineering Computations. M. K. Jain-S. R. K. Iyengar – R. K. Jain Willey Eastern Limited. New Age International (p) Ltd., Publishers, Reprint 2004, ISBN: 81-224-1461-3 56789101112.
2. Numerical Methods for Engineering Problems by N. Krishna Raju and K. U. Muthu, M.C. Millan Publishers, New Delhi
3. Numerical Methods for Engineers Stevan C. Chopra, Raymond P. Canal Mc. Graw Hill Book Company. April 2009

Reference books

1. C Language and Numerical methods by C. Xavier – New Age International Publisher. Reprint March 2012 ISBN: 978-81-224-1174-4.
2. Computer based numerical analysis by Dr. M. Shanta Kumar, Khanna Book publishers New Delhi.