

Numerical Method

Course Title: Numerical Method
Course No.: CSC207
Nature of the Course: Theory + Lab
Semester: III

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course contains the concepts of numerical method techniques for solving linear and nonlinear equations, interpolation and regression, differentiation and integration, and partial differential equations.

Course Objectives: The main objective of the course is to provide the knowledge of numerical method techniques for mathematical modeling.

Course Content:

Unit 1: Solution of Nonlinear Equations (8 Hrs.)

- 1.1 Errors in Numerical Calculations, Sources of Errors, Propagation of Errors, Review of Taylor's Theorem
- 1.2 Solving Non-linear Equations by Trial and Error method, Half-Interval method and Convergence, Newton's method and Convergence, Secant method and Convergence, Fixed point iteration and its convergence, Newton's method for calculating multiple roots, Horner's method

Unit 2: Interpolation and Regression (8 Hrs.)

- 2.1 Interpolation vs Extrapolation, Lagrange's Interpolation, Newton's Interpolation using divided differences, forward differences and backward differences, Cubic spline interpolation
- 2.2 Introduction of Regression, Regression vs Interpolation, Least squares method, Linear Regression, Non-linear Regression by fitting Exponential and Polynomial

Unit 3: Numerical Differentiation and Integration (8 Hrs.)

- 3.1 Differentiating Continuous Functions (Two-Point and Three-Point Formula), Differentiating Tabulated Functions by using Newton's Differences, Maxima and minima of Tabulated Functions
- 3.2 Newton-Cote's Quadrature Formulas, Trapezoidal rule, Multi-Segment Trapezoidal rule, Simpson's 1/3 rule, Multi-Segment Simpson's 1/3 rule, Simpson's 3/8 rule, Multi-Segment Simpson's 3/8 rule, Gaussian integration algorithm, Romberg integration

Unit 4: Solving System of Linear Equations (8 Hrs.)

- 4.1 Review of the existence of solutions and properties of matrices, Gaussian elimination method, pivoting, Gauss-Jordan method, Inverse of matrix using Gauss-Jordan method
- 4.2 Matrix factorization and Solving System of Linear Equations by using Dolittle and Cholesky's algorithm
- 4.3 Iterative Solutions of System of Linear Equations, Jacobi Iteration Method, Gauss-Seidal Method

- 4.4 Eigen values and eigen vectors problems, Solving eigen value problems using power method.

Unit 5: Solution of Ordinary Differential Equations (8 Hrs.)

- 5.1 Review of differential equations, Initial value problem, Taylor series method, Picard's method, Euler's method and its accuracy, Heun's method, Runge-Kutta methods
- 5.2 Solving System of ordinary differential equations, Solution of the higher order equations, Boundary value problems, Shooting method and its algorithm

Unit 6: Solution of Partial Differential Equations (5 Hrs.)

- 6.1 Review of partial differential equations, Classification of partial differential equation, Deriving difference equations, Laplacian equation and Poisson's equation, engineering examples

Laboratory Works:

The laboratory exercise should consist program development and testing of non-linear equations, system of linear equations, interpolation, numerical integration and differentiation, linear algebraic equations, ordinary and partial differential equations. Numerical solutions using C or Matlab.

Text Books:

1. W. Cheney and D. Kincaid, "*Numerical Mathematics and Computing*", 7th Edition, Brooks/Cole Publishing Co, 2012
2. C.F. Gerald and P.O. Wheatley, "*Applied Numerical Analysis*", 9th Edition, Addison Wesley Publishing Company, New York, 2011

Reference Books:

1. E. Balagurusamy, "Numerical Methods", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1999
2. W.H. Press, B.P. Flannery et al., "*Numerical Recipes: Art of Scientific Computing*", 3rd Edition, Cambridge Press, 2007.
3. J. M. Mathews and K. Fink, "Numerical Methods using MATLAB", 4th Edition, Prentice Hall Publication, 2004