Gokaraju Rangaraju Institute of Engineering and Technology
(Autonomous)

NUMERICAL METHODS

Sub. Code: GR14A1004 **L T P C**
I Year II Sem 2 1 0 3

Prerequisites: Elementary calculus, partial differentiation, 2-D analytical geometry and Fourier transforms

Course objectives
1. To explain the distinction between analytical and approximate solutions arising in mathematics
2. To acquire skills that equip us to approximate a hidden function using data
3. To learn methods that provide solutions to problems hitherto unsolvable due to their complex nature

Course outcomes: At the end of the course, the student will be able to
1. Develop the skill of determining approximate solutions to problems having no analytical solutions in different contexts
2. Solve problems related to cubic spline fitting and approximation of functions using B-splines and least squares
3. Develop the skill of finding approximate solutions to problems arising in linear differential equations

Unit-I Root finding techniques and Numerical solution of linear algebraic systems: Bisection method-Regula Falsi- Fixed point iteration method-Newton Raphson method - Rate of convergence of the above methods (without proof).
LU decomposition method-Cholesky's method-Jacobi and Gauss Seidel iteration methods- Convergence of iterative methods (without proof).

Unit-II Interpolation and Cubic Splines: Finite differences - Forward, backward and central differences, Relationship between operators- Interpolation with uniform data-Newton's forward and backward difference interpolation formulas- Gauss forward, Gauss backward and Stirling's central interpolation formulas- Lagrange and Newton's divided difference interpolation formulas for non-uniform data- Cubic spline interpolation.

Unit-III Curve fitting and B-spline approximation: Method of least squares- Fitting a straight line, and second degree parabola, exponential and power curves to data. Approximation of functions by B-Splines (Linear and Quadratic cases only).

Unit-IV Numerical differentiation and numerical integration: Numerical differentiation using the Newton's forward, backward and central difference formulas.
Numerical integration by Trapezoidal rule, Simpson's 1/3rd and $3/8^{th}$ rules, Gauss-Legendre one point, two point and three point rules.

Unit-V Numerical solution of initial and boundary value problems in ODE: Initial Value Problems: Picard's method of successive approximation, Solution by Taylor series method, Euler method, Runge-Kutta methods of second and fourth orders. Predictor-corrector methods, Combinations of first and second order P-C methods.
Boundary Value Problems in ODE: Finite difference methods for solving second order linear ODE.

Teaching methodologies
1. Tutorial sheets uploaded in website
2. NPTEL video lectures
3. MATLAB exercises for visualization

Text Books
1. Advanced Engineering Mathematics: R.K.Jain and S.R.K.Iyengar- Narosa Publishing House.
2. Advanced Engineering Mathematics: Erwin Kreyszig- Wiley.
3. Introductory methods of Numerical Analysis (5^{th} edition)-S.S.Sastry- PHI.

Reference Books
1. Applied Numerical Methods using MATLAB- Yang, Cao, Chung & Morris – Wiley Interscience
2. Numerical methods in Engineering with MATLAB-Jaan Kiusalaas -- Cambridge University Press.