Numerical Methods

Course objective:
The course aims to introduce numerical methods used for the solution of engineering problems. The course emphasizes algorithm development and programming and application to realistic engineering problems.

1. Introduction, Approximation and errors of computation(4 hours)
    a. Introduction, Importance of Numerical Methods
    b. Approximation and Errors in computation
    c. Taylor's series
    d. Newton's Finite differences (forward, Backward, central difference, divided difference)
    e. Difference operators, shift operators, differential operators
    f. Uses and Importance of Computer programming in Numerical Methods.

2. Solutions of Nonlinear Equations(5 hours)
    a. Bisection Method
    b. Newton Raphson method(Two equation solution)
    c. Regula-Falsi Method, Secant method
    d. Fixed point iteration method
    e. Rate of Convergence and comparisons of these Methods

3. Solution of system of linear algebraic equations(8 hours)
    a. Gauss elimination method with pivoting strategies
    b. Gauss-Jordan method
    c. LU Factorization
    d. Iterative methods (Jacobi method, Gauss-Seidel method)
    e. Eigen value and Eigen vector using Power method

4. Interpolation(8 hours)
    a. Newton's Interpolation(forward, backward)
    b. Central difference interpolation: Stirling's Formula, Bessel's Formula
    c. Lagrange interpolation
    d. Least square method of fitting linear and nonlinear curve for discrete data and continuous function
    e. Spline Interpolation(Cubic Spline)

5. Numerical Differentiation and Integration(6 hours)
    a. Numerical Differentiation formulae
    b. Maxima and minima
    c. Newton-Cote general quadrature formula
    d. Trapezoidal, Simpson's 1/3, 3/8 rule
    e. Romberg integration
    f. Gaussian integration(Gaussian–Legendre Formula 2 point and 3 point)

6. Solution of ordinary differential equations(6 hours)
    a. Euler's and modified Euler's method
    b. Runge Kutta methods for 1st and 2nd order ordinary differential equations
    c. Solution of boundary value problem by finite difference method and shooting method.

7. Numerical solution of Partial differential Equation(8 hours)
    a. Classification of partial differential equation(Elliptic, parabolic, and Hyperbolic)
    b. Solution of Laplace equation(standard five point formula with iterative method)
    c. Solution of Poisson equation(finite difference approximation)
    d. Solution of Elliptic equation by Relaxation Method
    e. Solution of one dimensional Heat equation by Schmidt method

Practical:

1. Algorithm and program development in C programming language of following: Generate difference table.
2. At least two from Bisection method, Newton Raphson method, Secant method
3. At least one from Gauss elimination method or Gauss Jordan method. Finding largest Eigen value and corresponding vector by Power method.
4. Lagrange interpolation. Curve fitting by Least square method.
5. Differentiation by Newton's finite difference method. Integration using Simpson's 3/8 rule
6. Solution of 1st order differential equation using RK-4 method
7. Partial differential equation (Laplace equation)
8. Numerical solutions using Matlab.

References:

1. Dr. B.S.Grewal, " Numerical Methods in Engineering and Science ", Khanna Publication, 7th edition.
2. Robert J schilling, Sandra l harries , " Applied Numerical Methods for Engineers using MATLAB and C.", 3rd edition Thomson Brooks/cole.
3. Richard L. Burden, J.Douglas Faires, "Numerical Analysis 7th edition" , Thomson / Brooks/cole
4. John. H. Mathews, Kurtis Fink ," Numerical Methods Using MATLAB 3rd edition " ,Prentice Hall publication
5. JAAN KIUSALAAS , " Numerical Methods in Engineering with MATLAB" , Cambridge Publication