Numerical Method

Course Title: Numerical Method
Course No.: CSC212
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 differentation, linear algebraic equations, ordinary and partial differential equations.Numerical solutions using C or Matlab.

Text Books:

1. W. Chency and D. Kincaid, "*Numerical Mathematics and Computing*", 7thEdition, Brooks/Cole Publishing Co, 2012
2. C.F. Gerald and P.O. Wheatley, "*Applied Numerical Analysis*", 9thEdition, 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 “, 4rd Edition, Prentice Hall Publication, 2004