Numerical Methods

Course Title: Numerical Methods
Course No: BIT203
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 covers different concepts of numerical techniques of solving non-linear equations, system of linear equations, integration and differentiation, and ordinary and partial differential equations.

Course Objective:
The main objective of this course is to provide concepts of numerical techniques for solving different types of equations and developing algorithms for solving scientific problems.

Course Contents:

Unit 1: Solution of Nonlinear Equations (7 Hrs.)

1.1 Errors in Numerical Calculations, Sources of Errors, Propagation of Errors, Review of Taylor's Theorem

1.2 Concept of Non-linear Equations, Solving Non-linear Equations: Trial and Error Method, Bisection Method, Newton Raphson Method, Secant Method, Fixed Point Method, False Position Method, Newton's Method for Calculating Multiple Roots, Evaluating Polynomials with Horner's Method

Unit 2: Interpolation and Regression (8 Hrs.)

2.1 Concept of Interpolation and Extrapolation, Lagrange's Interpolation, Newton's Interpolation using divided differences, forward differences and backward differences.

2.2 Concept of Regression, Regression vs. Interpolation, Least Squares Methods, Linear Regression, Non-linear Regression: Exponential and Polynomial

Unit 3: Numerical Differentiation and Integration (9 Hrs.)

3.1 Concept of Differentiation, 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 Concept of Integration, 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

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

4.1 Existence of Solutions, Properties of Matrices, Matrix Representation, Gaussian Elimination Method, Partial and Complete Pivoting, Gauss-Jordan method, Inverse of matrix using Gauss-Jordan method

4.2 Matrix factorization and Solving System of Linear Equations by using Do-little and Cholesky'salgorithm

4.3 Iterative Solutions of System of Linear Equations, Jacobi Iteration Method, Gauss-Seidal Method

4.4 Eigen Values and Eigen Vectors Problems, Power Method.

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

5.1 Concept of Differential Equations, Initial Value Problem, Taylor Series Method, Euler's Method, 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

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

6.1 Concept of Partial Differential Equations, Classification of PDE, Deriving Difference Equations, Laplacian Equation and Poisson's Equation.

Laboratory works:

The laboratory exerciseshould consist programs for implementing

- Non-linear equations
- System of linear equations
- Interpolation and Regression
- Numerical integration and differentation
- Solving ordinary and partial differential equations

Text Books:

1. W. Chency and D. Kincaid, "*Numerical Mathematics and Computing*", 7th Edition, Brooks Cole Publisher
2. C.F. Gerald and P.O. Wheatley, *"Applied Numerical Analysis*", 9th Edition, Addison Wesley Publisher

Reference Books:

1. W.H. Press, B.P. Flannery et al., "*Numerical Recipes: Art of Scientific Computing*", 3rd Edition, Cambridge Press.
2. J. M. Mathews and K. Fink, "Numerical Methods using MATLAB ", 4rd Edition, Prentice Hall Publication