Department Of Computer Science and Engineering
Kathmandu University
Dhulikhel, Kavre

Subject: Numerical Methods **Course: MCSC 202**

Level: B.E./B.Sc 2nd Year 2nd Semester **Credit Hours: 3**

The course will introduce the fundamentals of numerical methods for engineering and applied science streams. The goal of the course is to provide a broad background in numerical methods with theoretical discussion and available computer programming language for theoretical components discussed in the class. Topics include basic introduction to programming language used for the course, errors in numerical computation, root finding for algebraic (linear and non-linear equations) and transcendental equation, interpolation, integration of IVP of ODE, solving IVP for ODE, numerical differentiation, solution of system of linear equations and curve fitting.

1. Basic introduction of Computer programming language [4]

Course goals and organization
Introduction to Numerical methods
Basic introduction of programming language

2. Errors in numerical computation
[5]

Mathematical preliminaries (statement only) Exact and approximate numbers Significant digits Error Absolute, relative and percentage errors Absolute error for the sum, product and quotient of any two numbers Upper limit for absolute error General error formula

3. Root findings [7]

Introduction
Bisection method
The Secant method
False position method (The Regula-Falsi method)
- Convergence of False Position method and Secant method

Newton – Raphson method
- Quadratic convergence of Newton - Raphson method
- Generalised Newton – Raphson method

The General Iteration method

- Linearly convergence of iteration method
- Acceleration of convergence (Aitken's Δ^2- process)

Solution to system of nonlinear equations

– Iteration method
– Newton-Raphson method

4. Finite differences and Interpolation [8]

Finite differences

- forward difference
- backward difference
- central difference

Detection of errors by the use of difference tables

Differences of a polynomial

Introduction for interpolation

Linear and quadratic interpolation and its extension for Newton interpolation formulae (Forward and backward) Central difference interpolation formulae (Derivation not required)

- Gauss's, Sterling's, Bessel's and Everett's formula
- p-value or interval for p-value for the above formulae

Lagrange interpolation formula and its inverse interpolation formula

Divided differences

- Newton's general interpolation formula

5. Solving ODE (IVP) [6]

Introduction

Solution based on

- Series solution method (Taylor and Picard)
- Tabulated values (Euler, Modified Euler and Runge-Kutta method of second and fourth order)

Solution of BVP using Finite difference method

6. Numerical Differentiation and Integration [7]

Introduction

Numerical differentiation based on interpolation

- Using Newton’s forward difference interpolation formula
- Using Newton’s backward difference interpolation formula

Numerical integration based on interpolation (Derivation using Newton’s forward difference formula)

- Trapezoidal rule
- Simpson’s 1/3 rule
- Simpson’s 3/8 rule

Numerical double integration

- Trapezoidal rule
- Simpson’s rule

7. Matrices and System of linear equations [6]

Review of matrices

Consistency of a linear system of equations

Solution of linear system of equations

- LU decomposition method
- Tridiagonal system method
- Iterative method (Gauss-Jacobi method and Gauss Seidel method)

8. Curve fitting [2]

Introduction

Least square fitting:

- Straight line fitting
- Non linear fitting (power function, polynomial of nth degree, exponential function)

Recommended Text Book

Introductory Methods of Numerical analysis, S. S. Sastry, PHI Learning Private Limited, New Delhi, 5th edition, 2012.

Supplementary Text Book

Numerical Methods for Scientific and Engineering computation, M. K. Jain, S. R. K Iyengar & R. K. Jain, New Age International Publisher, 4th edition, 2005.