Adama Science and Technology University

College of Applied Natural Science

Department of Applied Mathematics

Course outline

Course Name: Numerical Analysis

Course Code: Math 3201

Credit Hour: 3

Lecture Hours: 2

Lab Hours/Tut: 3

Year and Semester offered: 3rd Year 2nd Sem.

Prerequisite: Linear Algebra (Math2201)

Synopsis

The Course is designed to develop the basic concepts in identifying sources of errors and error estimations, solving applied modeled Algebraic, Transcendental and systems of linear equations in different areas of studies classically and using computer applications. It also enables students to identify and use the Forward, Backward, Average, Central difference and Shift Operators. Moreover, find the value of unknown function between two known values using different methods of interpolations, and find the derivative of unknown function at a given known point and between two known points using different methods. Finally, find the definite integral of functions those are difficult to find anti-derivatives easily using different numerical methods and Obtain the definite integral of a given functions given as a discrete set of values. This course discusses basic concepts in error estimation, solutions of non-linear equations, solutions of system of linear equations and non-linear equations, finite differences, numerical interpolations, numerical differentiation and numerical integration.

Course Learning Outcome (CLO): At the end of the course the student will be able to

CLO-1 Apply basic concepts of errors to minimize errors in scientific computing problem solving

CLO-2 Apply programming skill for problem solving in science

CLO-3 Use the fundamentals of direct and iterations in problem solving

CLO-4 Apply the skills of approximation methods in scientific computing

CLO-5 Use the knowledge of error and accuracy in real data analysis

CLO-6 Apply mathematical methods for solving complex problems in the society

Course Content

Chapter 1: Basic Concepts in Error Estimation

1.1. Introduction; Some Mathematical preliminaries
1.2. Definition and Sources of error
1.3. Computer representation of numbers
1.4. Absolute, relative and percentage errors
1.5. Decimal places and significant digits
1.6. Computer arithmetic
1.7. Propagation of errors; general error formula

Chapter 2: Numerical Solution of Algebraic and Transcendental Equations

2.1. Introduction
2.2. The Bisection method
2.3.Newton – Raphson (or Newton‘s method)

2.4. False - Position and Secant methods
2.5. Fixed-Point iteration method

Chapter 3: Numerical Solutions of Systems of Linear Equations

3.1. Introduction
3.2. Direct methods
  3.2.1. Gauss elimination method
  3.2.2. LU –Decomposition method
3.3 Iterative methods
  3.3.1 Jacobi‘s method
  3.3.2 Gauss – Seidel method

Chapter 4: Interpolations

4.1 Introduction
4.2 Finite differences
  4.2.1 Forward differences
  4.2.2 Backward differences
  4.2.3 Other differences (central differences, shift operator, and averaging operator)
4.3 Interpolation with equally spaced points
  4.3.1 Newton‘s forward interpolation formula
  4.3.2 Newton‘s backward interpolation formula
4.4 Interpolation with unequally spaced points
  4.4.1 Newton‘s divided differences interpolation formula
  4.4.2 Lagrange‘s interpolation method
4.5 Approximation: Curve fitting
  4.5.1 linear least squares
  4.5.2 Quadratic least squares

Chapter 5: Numerical Differentiation and Integration

5.1: Introduction
5.2: Numerical Differentiation
  5.2.1. Derivatives using Newton‘s forward interpolation formula
  5.2.2. Derivatives using Newton‘s backward difference formula
  5.2.3. Derivatives using Newton‘s divided differences interpolation formula (for unequally spaced data)
5.3: Numerical Integration
  5.3.1. Newton-Cotes Quadrature formula
  5.3.2. Trapezoidal rule
  5.3.3. Simpson‘s rules

Assessment

- Quiz 10%
- Assignment 10%
- Mid 20%
- Lab Assignment 10%
- Final Exam 50%

Text book and reference:

1. Burden, R.L., and Faires, J.D., Numerical analysis, 5th ed., PWS publishing, Boston, 1993.
2. Sastry, S.S, Introductory Methods of Numerical Analysis, Prentice-Hall, New Delhi, 1998
3. Grewal, B.S., Numerical Methods in Engineering and Science, Khanna, New Delhi, 1994.
4. Chapra, S.C., and Raymond, P.C., Numerical Methods for Engineering, 3rd ed., McGraw-Hill, New York, 1998.
5. Gerald . Wheatley, Applied Numerical Analysis, 7th edition,