Numerical Analysis Fall-2023

Semester: Fall 2021	Credit hours: 3	Venue: MTC-20
Instructor: Abdul Majid	Pre-requisite: Calculus	Class Timings: Tue and Th:11:30-12:45
Email: amajid@iba.edu.pk	Office hours: TBA	Office location: 233 Tabba

Course description

This is the first course in Numerical Analysis offered to undergraduate students in Computer Science and Econ-Math Majors. In this course, students will be introduced to numerical approaches to solving algebraic equations, interpolation techniques, numerical techniques for differential equations and approximation methods for integrals. Both theory and applications of the methods will be covered at length. In addition, error analysis of each method will also be discussed. Subject to the availability of time we will also cover some topics from Finite Element and Finite Difference techniques to Partial Differential Equations. There will be strong emphasis on writing MATLAB/Python codes of each method we discuss in class. Strong background of Calculus and Linear Algebra is required to have in depth understanding of the course.

Learning outcomes

At the end of course, students are expected to be able to differentiate between exact and approximate methods for solving equations in mathematics. They will know that exact method for solving equations are limited and in real world system we often need to turn to approximations. Students will have learnt how to deal with various types of errors incurred due to approximations made in numerical analysis. Ideally, they would get expertise in each method we discuss in class and should be able to decide which method is suitable to which equation. Their vision of mathematics would be broadened and they will appreciate usefulness of mathematics in other related fields such as economics, computer, social and physical sciences.

Course text

- Numerical Analysis by Richard L. Burden and J. Douglas Faires 9th edition.
- Applied Numerical Analysis using Matlab by Laurene V. Fausett second edition.

Grading plan

- Projects/Assignments 50%
- Midterm 25%

- Final Exam 25%

Plagiarism policy

You are encouraged to collaborate and discuss problems with each other, however, solutions to the assignment problems and code should be written in your own words. All plagiarism cases will be strictly dealt according to the IBA policy.

Topics covered

Calculus Review, Types of Errors, Algorithm, Convergence, Bisection Method, Newton's Method, Fixed Point Iterations, Error Analysis, Interpolation Technique, Numerical Differentiation, Numerical Integration, Adaptive Quadrature Methods, Gaussian Quadrature, Multiple Integrals, Initial Value Problems, Euler's Method, Runge-Kutta Methods, Multistep Methods, System of Differential Equations, Stability, Error Analysis, Iterative Techniques in Matrix Algebra, Relaxation Techniques, Eigenvalues, Eigenvectors, Conjugate Gradient Method, Numerical Solutions of Nonlinear System of Equations, Finite Element(optional) and Finite Difference(optional).

Tentative weekly lecture plan

Week	Topics covered	Articles
1	Calculus review and error analysis	1.1-1.4
2	Bisection method and fixed point iterations	2.1-2.2
3	Newton's method and error analysis for iterative methods	2.3-2.5
4	Interpolation, Lagrange polynomial, Neville's method	3.1-3.2
5	Divided difference, Hermite polynomial	3.3-3.4
6	Cubic Spline and parametric curves	3.5-3.6
7	Numerical differentiation,Richardson's extrapolation	4.1-4.2
8	Numerical integration and quadratures	4.3-4.7
9	Multiple integrals and improper integrals	4.8-4.9
10	Initial value problem, Euler's mathod, higher order Taylor's methods	5.1-5.3
11	Runge-Kutta methods and error analysis	5.4-5.5
12	Multistep methods, extrapolations	5.6-5.8
13	Numerical approches to system of linear equation, eigenvalue problem	handouts
14	shooting method, finite difference and finite element methods	handouts