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CS 374 – Computational and Numerical Methods

Academic year: 2024-25
Semester: Autumn 24

Instructor
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Credit Structure : (L-T-P-Cr): (3-0-3-4.5)
Course Code: CS 374
Program/ Semester: B.Tech, Semester V
Category: Core
Lectures: Tuesday:8:00-8:50am
Wednesday: 9:00-9:50am
Friday: 9:00-9:50am

Lab: TBD

TA: TBD

Course Overview

There are several problems in applications that can't be solved analytically. For that reason people search for approximate solutions. The aim of this course is to make the students learn some numerical techniques to find the approximate solutions of a variety of problems such as numerical solutions of algebraic and transcendental equations, numerical solutions to systems of algebraic equations, interpolation, numerical differentiation, numerical integration, numerical solutions of differential equations. For hands-on experience in

problem solving, students will be writing in some of the programming language of their choice.

Tentative Course Content

Computer Arithmetic- Floating Point Numbers, Errors

Root finding- Numerical solutions to Algebraic and Transcendental equations, Bisection method, Secant method and Newton Raphson method, Fixed point iteration method.

Interpolation- Lagrange interpolation, Divided difference Interpolation, Newton's forward and backward interpolation, Piecewise interpolation and Spline Interpolation.

Numerical Differentiation and Integration- Numerical differentiation using Lagrange interpolation, using difference operators, and using method of undetermined coefficients, Numerical Integration, Trapezoid rule, Simpsons rule and Gaussian quadrature rule.

Solution of Systems of Linear Equations- Numerical Solutions to System of Algebraic equations, Gaussian elimination method, Gauss Jordan method, Gauss-Seidel iteration method, Jacobi iteration method, Numerical solution to nonlinear equations, Newton's method using Jacobian

Ordinary Differential Equations- Numerical Solution of Differential equation, Euler's method, Midpoint rule, Second order Runge-Kutta method, fourth order Runge-Kutta method, Application to boundary value problem

Expected Outcome

The students after completing the course will get a basic overview of Numerical methods, Students will be able to understand the well-known numerical methods for solving problems in science and engineering. After the completion of the course the students will be able to understand which numerical methods should be applied to a particular problem.

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
X	**X**	**X**	**X**	**X**							**X**

Textbook

The following textbooks will be helpful. We will provide many additional materials such as lecture notes etc. during the course.

1. Elementary Numerical Analysis, K. Atkinson and W. Han, Wiley & Sons.
2. Numerical Analysis, Mathematics of Scientific Computing, D. Kincaid, W.Cheney, American Mathematical Society.

3. An Introdution to Numerical Methods and Analysis, James F. Epperson, Wiley and Sons.
4. Numerical Method for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar, and R. K. Jain, New Age International Publishers.
5. Computer Oriented Numerical Methods, V. Rajaraman, Prentice Hall of India

Mark Distribution (Tentative) / Grading Policy

Labwork - 30%
Midterm Test 1- 20%
Midterm Test 2- 20%
Final Test - 30 %

Tutorials: No
Lab: Yes

Course Resources

Lecture notes.

Lecture notes/ class notes will be posted and made available for students after the lecture.

Labs

In labs the students will do hands on to implement the numerical methods using a programming language. Instructor and TA will help the students in labs.

Office Hours

Office hours with the instructor will be used to answer specific questions and can also be scheduled by appointment.

Tentative Lecture Schedule

Sl. No.	Description	No. of Lectures
1	**Introduction to Numerical Analysis, Computer Arithmetic**	**3**
2	**Root Finding:** Bisection Method, Secant Method, Newton-Raphson Method, Fixed Point Iteration Method	**7**
3	**Interpolation:** Lagrange Interpolation, Divided Difference Interpolation, Newton's forward and backward Interpolation, Piecewise Interpolation, Spline Interpolation	**7**
4	**Numerical Integration and Differentiation:** Trapezoid Rule, Simpson's Rule, Gaussian Quadrature Rule, Differentiation Using Interpolation, Differentiation using Method of undetermined coefficients	**8**
5	**Solution of Systems of Linear Equations:** Gauss Elimination Method, Gauss Jordan Method, Gauss-Seidel Method, Jacobi Iteration Method, Newtons Method for solving nonlinear systems	**6**
6	**Numerical solutions to Ordinary Differential Equations:** Euler's Method, Midpoint Rule, Second Order and fourth order Runge-kutta Method, Boundary Value Problems	**8**

Weekly Plan (Tentative)

Week	Topics
1	Introduction and Computer Arithmetic
2	Bisection Method, Secant Method
3	Newton-Raphson Method, Fixed Point Iteration Method
4	Lagrange Interpolation, Divided Difference Interpolation
5	Newton's forward and backward Interpolation, Piecewise Interpolation
6	Spline Interpolation, Trapezoid Rule,
7	Simpson's Rule, Gaussian Quadrature Rule

8	Differentiation Using Interpolation, Differentiation using Method of undetermined coefficients
9	Gauss Elimination Method, Gauss Jordan Method
10	Gauss-Seidel Method, Jacobi Iteration Method
11	Newtons Method for solving nonlinear systems
12	Euler's Method, Midpoint Rule
13	Second Order and fourth order Runge-kutta Method,
14	Boundary Value Problems