25MA803 Advanced Numerical Methods 3-0-2-4

Course Description:
This course is offered to PhD students in Mathematics and Engineering. The course includes error analysis, convergence criteria, and methods for solving linear and nonlinear equations. Students will explore numerical differentiation and integration techniques such as the Trapezoid, Simpson's, and Gauss quadrature methods. The course emphasizes hands-on learning through MATLAB to implement and analyze the convergence and accuracy of these methods. By the end of the course, students will be equipped to apply numerical methods effectively in real-world applications.

Learning Objectives:

- Understand error analysis and convergence properties of numerical methods.
- Solve linear and nonlinear equations, and compute eigenvalues and eigenvectors using iterative techniques.
- Apply numerical differentiation and integration techniques like Trapezoid, Simpson's, and Gauss quadrature methods.
- Implement numerical algorithms using MATLAB to analyze accuracy and convergence.

Pedagogy:
Hands-on MATLAB Sessions, Problem-Solving and Case Studies, Group Discussions and Peer Learning

Course Outcome:

CO1: Apply error analysis to assess the accuracy and stability of numerical methods in solving mathematical problems.
CO2: Solve systems of linear and nonlinear equations using iterative and direct methods, and compute eigenvalues and eigenvectors.
CO3: Implement numerical differentiation and integration techniques such as Taylor series, Trapezoid, Simpson's, and Gauss quadrature methods.
CO4: Utilize MATLAB to implement, analyze, and optimize numerical algorithms for solving mathematical problems.
CO5: Evaluate the convergence and accuracy of various numerical methods and choose appropriate techniques for specific applications.

CO-PO Mappings

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	1	-	-	-	-	-	-	3
CO2	3	3	-	-	1	-	-	-	-	-	-	2
CO3	3	3	-	-	1	-	-	-	-	-	-	3
CO4	1	1	-	-	3	-	-	-	-	-	-	3
CO5	2	2	-	-	1	-	-	-	-	-	-	3

Syllabus:

1. Unit 1
   Error analysis for Iterative Methods, Convergence: Super linear Convergence, Linear Convergence, Quadratic Convergence.
2. Unit 2
   System of Linear Equation: Gaussian Elimination, Gauss Jordan, Eigen value and eigen vector problem by power method. Practical exercises using MATLAB to analyze convergence and how the methods work.
3. Unit 3
   Nonlinear Equation: Newton's Method, Simple fixed-point iteration, Iterative method for system of Nonlinear Equation. Practical exercises using MATLAB to analyze convergence and how the methods work.
4. Unit 4
   Numerical Differentiation and Integration: Using Taylor Series to derive difference formulas, Trapezoid's Method, Simpson's Method, Gauss quadrature Newton's Method. Practical exercises using MATLAB to analyze convergence and how the methods work.

References:

1. Canale, R. P., & Chapra, S. C. (2014). *Numerical methods for engineers*. Mcgraw-hill Education-Europe.
2. Burden, R. L., & Faires, J. D. (1997). Numerical analysis, brooks.

Evaluation Pattern:

Internal		External	
Four Assignments	40 Marks	Mini MATLAB Project	30 Marks
Three Presentations	30 Marks		
Total Internal	70 Marks	Total External	30 Marks