Lesson Plan

Course Title: Numerical Analysis

Course No.: CSE-245 **Credit : 3.0** **Contact Hours: 3**

Course Objectives:

This course will emphasize the development of numerical algorithms to provide solutions to common problems formulated in science and engineering. The primary objective of the course is to develop the basic understanding of the construction of numerical algorithms, and perhaps more importantly, the applicability and limits of their appropriate use. The various scientific phenomena can be mathematically modeled using equations and expressions. To engineer these phenomena, one may have to solve these mathematical models by - analytical, graphical, or approximations. Numerical analysis is a branch that deals with the approximate solution formations of various mathematical models.

Course Learning Outcomes:

The learning outcomes for this course are as follows:

1. Understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems
2. Apply numerical methods to obtain approximate solutions to mathematical problems
3. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
4. Analyze and evaluate the accuracy of common numerical methods
5. Implement numerical methods in MATLAB.
6. Write efficient, well-documented MATLAB code and present numerical results in an informative way.

Syllabus:

Introduction; Errors in numerical calculations, Approximations and round-off errors, Truncation errors; Solution of algebraic and transcendental equations: method of iteration, False Position method, Newton-Rhapson method, Bisection method, Secant method; Solution of simultaneous linear equations: Cramer's rule, Gauss Elimination method, Gauss-Jordan method, Factorization method, Iteration method, Jacobi method, Gauss-Seidel method, Choleski's process; Interpolation; diagonal and horizontal difference, differences of a polynomial, Newton's formula for forward and backward interpolation, Spline interpolation, Integration: General quadrature formula, Trapezoidal rule, Simpson's rule, Weddle's rule, Solution of ordinary differential equations: Euler's method, Picard's method, Milne's method, Taylor's series method, Runge-Kutta method, Least squares approximation of functions: linear and polynomial regression, fitting exponential and trigonometric functions.

Lesson Learning Outcomes

Lesson No.	Course Contents	Lesson Learning Outcomes	Teaching-Learning Method	Assessment Strategy
Lesson-01	Overview and Importance of the Course	✓ To know about the learning outcomes of this course ✓ To know the importance of Numerical Analysis course for CSE graduate	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Not applicable
Lesson-02	Introduction	✓ To know the introduction of numerical analysis ✓ To know the errors in numerical calculations	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-03	Introduction	✓ To know about the approximations and round-off errors ✓ To know about the truncation errors	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-04	Solution of algebraic and transcendental equations	✓ To know the iteration method to solve the algebraic and transcendental equation ✓ To solve a numerical problem using iteration method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-05	Solution of algebraic and transcendental equations	✓ To know the false position method to solve the algebraic and transcendental equation ✓ To solve a numerical problem using false position method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-06	Solution of algebraic and transcendental equations	✓ To know the Newton-Raphson method to solve the algebraic and transcendental equation ✓ To solve a numerical problem using false position method ✓ To know the convergence of Newton-Raphson method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-07	Solution of algebraic and transcendental equations	✓ To know the bisection method to solve the algebraic and transcendental equation ✓ To solve a numerical problem using bisection method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-08	Solution of algebraic and transcendental equations	✓ To know the secant method to solve the algebraic and transcendental equation ✓ To solve a numerical problem using secant method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-09	Solution of	✓ To know the Cramer's rule to	✓ Class Lecture	Class Test, Quiz,

	simultaneous linear equations	solve the simultaneous linear equation ✓ To solve a system of linear equation using Cramer's rule	✓ Multimedia Presentation ✓ Question-answer	Exam, etc
Lesson-10	Solution of simultaneous linear equations	✓ To know the Gauss elimination method to solve the simultaneous linear equation ✓ To solve a system of linear equation using Gauss elimination method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-11	Solution of simultaneous linear equations	✓ To know the Gauss Jordan method to solve the simultaneous linear equation ✓ To solve a system of linear equation using Gauss Jordan method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-12	Solution of simultaneous linear equations	✓ To know the factorization method to solve the simultaneous linear equation ✓ To solve a system of linear equation using factorization method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-13	Solution of simultaneous linear equations	✓ To know the iteration method to solve the simultaneous linear equation ✓ To solve a system of linear equation using iteration method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-14	Solution of simultaneous linear equations	✓ To know the Jacobi method to solve the simultaneous linear equation ✓ To solve a system of linear equation using Jacobi method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-15	Solution of simultaneous linear equations	✓ To know the Gauss-Seidel method to solve the simultaneous linear equation ✓ To solve a system of linear equation using Gauss-Seidel method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-16	Solution of simultaneous linear equations	✓ To know the Choleski's process to solve the simultaneous linear equation ✓ To solve a system of linear equation using Choleski's process	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-17	Finite differences	✓ To know the finite differences ✓ To know the forward, backward and central differences ✓ To know the differences of polynomial	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc

Lesson-18	Finite differences	✓ To know the factorial polynomial ✓ To know the polynomial in factorial notation ✓ To know error propagation in difference table	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-19	Interpolation with equal interval	✓ To know the Gregory-Newton formula for forward interpolation ✓ To solve a numerical problem using Gregory-Newton forward interpolation formula	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-20	Interpolation with equal interval	✓ To know the Gregory-Newton formula for backward interpolation ✓ To solve a numerical problem using Gregory-Newton backward interpolation formula	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-21	Central difference interpolation formula	✓ To know the Gauss's forward interpolation formula for central difference ✓ To solve a numerical problem using Gauss's forward interpolation formula	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-22	Central difference interpolation formula	✓ To know the Gauss's backward interpolation formula for central difference ✓ To solve a numerical problem using Gauss's backward interpolation formula	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-23	Central difference interpolation formula	✓ To know the Stirling's interpolation formula for central difference ✓ To solve a numerical problem using Stirling's interpolation formula	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-24	Central difference interpolation formula	✓ To know the Bessel's interpolation formula for central difference ✓ To solve a numerical problem using Bessel's interpolation formula	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-25	Spline interpolation	✓ To know the spline interpolation formula ✓ To solve a numerical problem using spline interpolation formula	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-26	Numerical integration	✓ To know the general quadrature formula for equidistance coordinates ✓ To know the trapezoidal rule for numerical integration ✓ Evaluate an integration using the trapezoidal rule	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-27	Numerical integration	✓ To know the Simpson's 1/3 and 3/8 rule for numerical	✓ Class Lecture ✓ Multimedia	Class Test, Quiz, Exam, etc

		integration ✓ Evaluate an integration using the Simpson's 1/3 and 3/8 rule ✓ Calculate the errors in Simpson's 1/3 and 3/8 rule	Presentation ✓ Question-answer	
Lesson-28	Numerical integration	✓ To know the Weddle's rule for numerical integration ✓ Evaluate an integration using the Weddle's 3/8 rule ✓ Calculate the errors in Weddle's rule	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-29	Numerical Solution to Ordinary Differential Equations	✓ To know the power and Taylor's series method ✓ To solve a differential equation using power and Taylor's series method	✓ Class Lecture ✓ Multimedia Presentation Question-answer	Class Test, Quiz, Exam, etc
Lesson-30	Numerical Solution to Ordinary Differential Equations	✓ To know the solution by Taylor's series method for higher order differential equations ✓ To solve a differential equation using Taylor's series method for higher order differential equations	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-31	Numerical Solution to Ordinary Differential Equations	✓ To know the Picard's method of successive approximation ✓ To solve a differential equation using Picard's method of successive approximation	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-32	Numerical Solution to Ordinary Differential Equations	✓ To know the Euler's method, modified Euler's method and improved Euler's methods ✓ To solve a differential equation using Euler's method, modified Euler's method and improved Euler's methods	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-33	Numerical Solution to Ordinary Differential Equations	✓ To know the Runge's method and Runge-Kutta methods ✓ To solve a differential equation using the Runge's method and Runge-Kutta methods	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-34	Numerical Solution to Ordinary Differential Equations	✓ To know the Runge-Kutta method for first order and higher order equations ✓ To solve a differential equation using Runge-Kutta method for first order and higher order equations	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-35	Numerical Solution to Ordinary Differential Equations	✓ To know the Milne's predictor and corrector formula ✓ To solve a differential equation using Milne's predictor and corrector formula	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-36	Least squares	✓ To know the curve fitting	✓ Class Lecture	Class Test, Quiz,

	approximation of functions	methods (i) graphical method (ii) group of average method ✓ To fit a curve using graphical method and group of average method	✓ Multimedia Presentation ✓ Question-answer	Exam, etc
Lesson-37	Least squares approximation of functions	✓ To fit a straight line using least square approximation method ✓ To fit a parabola using least square approximation method	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-38	Review whole course	✓ To fit a straight line and parabola using some of square of residuals method ✓ To fit a straight line and parabola using method of moments	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Class Test, Quiz, Exam, etc
Lesson-39	Review whole course	✓ To know the summary of the courses	✓ Class Lecture ✓ Multimedia Presentation ✓ Question-answer	Not applicable

RECOMMENDED BOOKS

Text Books:

1. Numerical Methods by V. N. Vedamurthy and N. Ch. S. N. Iyengar

2. Numerical Analysis by A. R. Vasishtha and Vipin Vasishtha

3. Numerical Methods for Engineers (7th edition) by Steven Chapra and Raymond Canale

Reference Books:

1. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyengar, and R. K. Jain