COURSE CONTENT

NUMERICAL ANALYSIS LABORATORY								
II Semester: ST								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
BSTE24	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		0	0	4	2	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Nil								

I. COURSE OVERVIEW:

This course introduces numerical techniques for solving linear and non-linear equations, curve fitting, integration, and ordinary differential equations (ODEs). Students will learn algorithms such as Bisection, Newton–Raphson, Secant, Gauss Elimination, Gauss–Seidel, Gauss–Jordan, Trapezoidal, Simpson's, Euler's, Runge–Kutta, Brent's, and Muller's methods. Emphasis is placed on computational implementation, enabling students to develop problem-solving skills using different programming languages.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Determination of roots of non-linear equations and solution of systems of linear equations using numerical methods.

II. Curve fitting and numerical integration using the method of least squares, Trapezoidal and Simpson's rules.

III. Numerical solution of ordinary differential equations using Euler's and Runge–Kutta methods.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Analyze the roots of non-linear equations using Bisection and Newton's methods to demonstrate accuracy in solving mathematical problems.

CO 2 Apply the method of least squares for curve fitting to validate data approximation and error minimization.

CO 3 Solve systems of linear equations using Gauss Elimination, Gauss–Seidel, and Gauss–Jordan methods to provide evidence of computational efficiency and correctness.

CO 4 Implement Trapezoidal and Simpson's rules for numerical integration to verify results against analytical solutions.

CO 5 Explain the application of Euler's method for solving ordinary differential equations to illustrate stepwise numerical approximation.

CO 6 Evaluate ordinary differential equations using Runge–Kutta methods to demonstrate improved accuracy in numerical solutions.

IV. COURSE CONTENT:

Week-I: Bisection Method
Apply the Bisection method to determine the roots of non-linear equations and prepare a report demonstrating convergence.

Week - II: Newton's Method
Implement Newton's method to find roots of non-linear equations and compare results with Bisection method outcomes.

Week-III: Curve Fitting
Perform curve fitting using the least squares approximation and validate results through error analysis.

Week-IV: Gauss Elimination Method
Solve systems of linear equations using the Gauss Elimination method and verify accuracy with sample problems.

Week-V: Gauss–Seidel Iteration Method
Apply the Gauss–Seidel iterative method to solve linear systems and evaluate rate of convergence.

Week-VI: Gauss–Jordan Method
Use the Gauss–Jordan method to solve linear equations and record computational steps for evidence of correctness.

Week-VII: Trapezoidal Rule
Implement the Trapezoidal rule for numerical integration and compare approximate results with exact integrals.

Week VIII: Simpson's Rule
Apply Simpson's rule for numerical integration and demonstrate improved accuracy over the Trapezoidal rule.

Week IX: Euler's Method
Use Euler's method to solve ordinary differential equations and interpret the numerical approximation graphically.

Week X: Runge–Kutta Method
Implement the Runge–Kutta method for solving ODEs and analyze its accuracy against Euler's method.

Week XI: Newton–Raphson Method
Solve non-linear equations using Newton–Raphson method and demonstrate convergence properties.

Week XII: Secant Method
Apply the Secant method for root finding and compare results with Newton–Raphson method.

Week XIII: Brent's Method
Implement Brent's method for solving equations and validate its robustness in convergence.

Week XIV: Muller's Method
Use Muller's method to solve equations and analyze its efficiency for complex roots.

V. TEXTBOOKS:
1. Steven Chapra and Raymond Canale, "*Numerical Methods for Engineers*", McGraw Hill, 7th Edition, 2015.

VI. REFERENCE BOOKS:
1. K. Sankara Rao, "*Numerical Methods for Scientists and Engineers*", PHI Learning, 4th Edition, 2018.

VII. ELECTRONICS RESOURCES:
1. https://www.iitg.ac.in/physics/fac/charu/courses/ph508/lab5.pdf?utm_source=chatgpt.com
2. https://www.youtube.com/watch?v=HtXDcu6l2_w&t=1s

VIII. MATERIAL ONLINE:
1. Course Outline Description
2. Laboratory manual