GUJARAT TECHNOLOGICAL UNIVERSITY

Minor Degree : Electrical and Computer
Subject Code: N114AK01
Semester – IV (w.e.f. AY 2024-25)
Subject Name: Numerical Methods for Engineers using C

Prerequisite: Differentiation, Integration, Matrix operation, Various Mathematical Series, Basic knowledge of Trigonometry, hyperbolic function and Programing in C.

Rationale: In some of the complex situations of mathematical modelling, it is quite difficult to solve the set of algebraic equations, ordinary differential equations, partial differential equations, and integral equations in the general domain or by analytical method. For complex and large systems, the solution is required to be obtained using numerical methods. Programming languages are the essential tools to study or solve complex problems using Numerical methods. such models. In this course, the students will gain the ability which enables them to select the appropriate numerical technique to solve a given engineering problem.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	0	30	0	100

Content:

Sr. No.	Content	Total Hrs
1	**General error analysis for multistep methods** Introduction, Errors in Numerical Computation, their types and estimation, Convergence, A general error analysis: Stability theory, Convergence theory, Relative stability, and weak stability	4
2	**Solution of linear algebraic equations** Introduction, Direct method for solving system of linear Equations - Gauss Elimination method, Gauss Jordan Method, Pivoting, LU-Decomposition, Iterative method for solving system of linear Equations: Gauss-Seidel Method, Gauss- Jacobi Method, Case Studies and Programming. **Solution of nonlinear algebraic equations** Introduction, Gauss-Seidel Method, Newton Raphson Method, Case Studies and Programming.	6
3	**Interpolation and Extrapolation:** Introduction, Newton's Forward and Backward Differences, Central Differences, Gauss's Forward and Backward Interpolation formulation, Sterling formula, Bessel's formula, Laplace-Everett formula. Lagrange's Interpolation formula for unequal Intervals, Newton divided difference method. Interpolation for Cubic Spline. Programming	6
4	**Numerical Differentiation and Integration** Introduction, Newton's forward, backward and central differences formulae to compute first and higher-order derivatives. Numerical Integration – Introduction, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Boole's rule, Weddle's rule, and Romberg Method. Programming	6

5	**Numerical solution of ordinary differential equations** Introduction, Taylor series method, Euler's Method, Modified Euler's Method, R.K. Method, Finite difference method. Multistep Methods: Adams- Bashforth Methods, Mine's Method. Programming	**10**
6	**Numerical Solution of Partial Differential Equations:** Introduction, Classification of Second-order Partial differential equations, Finite-Difference approximation to Derivatives, Laplace's equation and its solution by Liebmann's process, Solution of Poisson's equation, Solutions of Parabolic and Hyperbolic equations. Programming	**10**

Suggested Specification table (Theory):

Distribution of Theory Marks (%)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
9	36	42	13	-	-

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference books:

1. "Introductory Methods of Numerical Analysis", By S.S.Sastry, PHI.
2. "Numerical Methods for Engineering", By Steven C Chapra, Raymond P Canale, TMH.
3. "Advanced Engineering Mathematics", By Erwin Kreyszig, John Wiley & Sons.
4. "Numerical Methods for Engineers and Scientists", By Bajpai A. C., John Wiley, 1977.
5. "Numerical Solution of Ordinary Differential Equations", By Kendall Atkinson, Weimin Han, David Stewart, A John Wiley & Sons, Inc., Publication

Course Outcomes: Upon completion of this course students should be able to:

No	**Course Outcomes**	% weightage
01	To solve the system of linear algebraic equations using direct and iterative methods, non-linear algebraic equations numerically, and error analysis.	20
02	To understand how to approximate the functions using interpolating and extrapolating the polynomials.	10
03	To understand how to differentiate and integrate numerically.	10
04	To solve ordinary differential equations numerically.	30
05	To solve Partial differential equations numerically.	30

List of Practicals:

1. Develop a program to solve a system of linear equations using Iterative methods.
2. Develop a program to solve a system of linear equations using Gauss Elimination, Gauss-Jordan, and LU-Decomposition methods.

3. Develop a program to obtain a solution of a set of non-linear algebraic equations using the Gauss-Seidel and Newton Raphson method.
4. Develop a program to compute the interpolation value using Newton's forward and backward difference formula.
5. Develop a program to compute the interpolation value using Gauss forward and backward Difference formula.
6. Develop a program to compute the interpolation value using Lagrange's and Newton's Forward Difference formula.
7. Develop a program to compute first and second-order derivatives using Newton's Forward and Backward difference formula.
8. Develop a program to compute integration using Trapezoidal and Simpson's 1/3, 3/8 rule.
9. Develop a program to obtain numerical solutions of Ordinary Differential Equations using the R. K. method.
10. Develop a program to obtain numerical solutions of Ordinary Differential Equations using the Finite difference method.
11. Develop a program to obtain numerical solutions of Elliptical Partial Differential Equations using the Finite-Difference method.
12. Develop a program to obtain numerical solutions of Parabolic Partial Differential Equations using the Finite-Difference method.
13. Develop a program to obtain numerical solutions of Hyperbolic Partial Differential Equations using the Finite-Difference method.