



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program

Level: UG

Branch: Minor/Hons. Electrical and Computer

Subject Code: BE040AK011

Subject Name: Numerical Methods for Engineers using C

w. e. f. Academic Year:	2025-26
Semester:	4 th
Category of the Course:	Core Courses

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

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	To solve the system of linear algebraic equations using direct and iterative methods, non-linear algebraic equations numerically, and error analysis.	20
CO-2	To understand how to approximate the functions using interpolating and extrapolating the polynomials.	10
CO-3	To understand how to differentiate and integrate numerically.	10
CO-4	To solve ordinary differential equations numerically.	30
CO-5	To solve ordinary differential equations numerically.	30

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	TH		Theory		Tutorial / Practical			
						ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
60	0	30	60	150	5	70	0	0	30	50	150

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA



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manual.

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

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.	10
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.	10
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.	10
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.	10
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, FiniteDifference approximation to Derivatives, Laplace's equation and its solution by Liebmann's process, Solution of Poisson's equation, Solutions of Parabolic and Hyperbolic equations.	10



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Programming.	
TOTAL	60

Suggested Specification table with Marks (Theory):

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

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

List of Practical:

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.



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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.

List of Open Source Software/learning website:

<https://fossee.in/> (IIT BOMBAY)

List of suggested activities for Problem Based Learning:

Sr. No.	Name of the activity	Activity Description and No. of hours	Suggested Evaluation Criteria	Targeted CO
1	Technical Video based learning related to the subject	Duration of video = 10h Report preparation & Presentation = 10h Total = 20h	Report /presentation based on the video learning outcomes.	CO1-CO5
2	Discussion on research paper based on relevant subject	4 research paper = 20h	Summarize research paper and evaluation critical parameters	CO1-CO5
3	Poster/chart/power point preparation on technical topics	Duration = 10 h	Based on poster/chart preparation and presentation skills	CO1-CO5
4	Application/Software development	Duration = 20 h	Depending on the complexity of the Application/Software	CO1-CO5
5	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.	CO1-CO5
6	Seminar / Presentation	Duration for study and preparation=5h Report writing=3h Presentation=2h Total=10h	Topic can be selected technical content beyond syllabus	CO1-CO5
7	Real world case studies-based	Duration of data	Based on in-depth	CO1-CO5



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	learning	collection/study = 10h Report preparation = 10h Total = 20h	study, technical depth, data collected, fact finding, etc.	
8	Self-learning on-line course	Minimum duration of the course should be 15h.	Examination based assessment at the end of course. Based on the certificate produced.	CO1-CO5
9	Complex problem solving	Maximum 4 problems. Study of the problem and solution finding, Total = 20h	Based on the depth of the solution submitted.	CO1-CO5
10	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS EXCEL or any other relevant software	5 small coding-based problems of 3h each. Total = 15h	Based on the coding solution submitted.	CO1-CO5
11	Assignment writing. Numerical based assignment is preferable.	5 assignments of 3h each. Total = 15h	Based on the assignment submitted.	CO1-CO5

- All the suggested activities should be related to the subject.
- Min 3 activities must be carried out as per the availability of faculties and students.
- The number of hours is suggestive.
- Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record keeping and to ensure transparency in the evaluation and assessment of Problem based learning activities.
