Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NMEC513	Numerical Methods	3	1	0	4

Course Objective
To study the numerical solution of linear and non-linear algebraic equations, solution of differentiation, integrations, PDEs and ODEs
Learning Outcomes
Upon successful completion of this course, students will: • be able to use FDM for discretization of governing equations (ODE and PDE). • be able to thoroughly analyze the accuracy and stability of various numerical schemes. • be able to write computer programs based on the learningsfrom this course. • be able to solve actual problems by using different numerical methods.

Unit No.	Topics to be Covered	L+T Hours	Learning Outcome
1	Introduction to Numerical methods.	2 L+1T	Numerical methods are gradually becoming the substitute of experimental methods
2	Solution of linear algebraic systems: Non-iterative method, Gauss elimination method, LU- factorization method, Matrix inversion method. iterative method, Gauss Seidel iterative method, Jacobi method, ill - conditioning problems, Tridiagonalization, Householder's method, QR-factorization	7L+ 1T	This unit will help students in learning to solve linear algebraic equations,
3	Solution of non-linear algebraic systems: Solution of equations by iterations, Fixed point iterations, Newton's method, Secant method, Bi-section method	5L+2T	Understanding the methods for solution of non-linear equations
4	Numerical differentiation: Taylor Series, Finite Difference, Accuracy, Modified Wavenumber Approach, Pade Approximation	4L+1T	Understanding and evaluating different finite difference approximation
5	Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule. Numerical double integration. Romberg Integration, Richardson Extrapolation, Adaptive Quadrature, Gauss Quadrature.	7L+3T	Learn and design optimum numerical techniques for integration
6	Finite Difference Methods: Different discretization techniques of ODE equations, Backward, forward and central differencing discretization schemes, Euler's explicit, implicit and semi-implicit methods, RungeKutta 2nd and 4th Order, Leap Frog, Adam Bashforth, System of ODE's, Boundary Value Problems: Shooting and Direct Methods. Truncation, Discretization, Round off errors. Consistency, stability and convergence. Fourier or von-Neumann stability analysis of Finite difference schemes	9L+3T	Understanding different types of errors, consistency, stability, and convergence during solving the governing ODE's
7	Applications to model problems: Semi Discretization, Stability Analysis: von Neumann Stability Analysis, Modified Wave number analysis: Heat Equation, Wave Equation. Implicit time advancement, Modified Equation, Du Fort-Frankel Method, Multi-dimensions, Implicit treatment, Approximate Factorization, ADI, Mixed time-step, Elliptic PDE.	8L+3T	Students may use different methods for solving PDE's like the actual heat/fluid flow and wave equations

	Total	42L+14T	

Text Books:

1. Fundamentals of Engineering Numerical Analysis, Parviz Moin, 2nd Edition, Cambridge.

2. Introductory Methods of Numerical Analysis: S. S. Sastry, 4th Edition, Prentice Hall of India Pvt Ltd.

Reference books:

1. Numerical Solution of Partial Differential Equations: G. D. Smith, Oxford University Press, 1985.

2. Computational Fluid Mechanics and Heat Transfer: D. A. Anderson, J. C. Tannehill and R. H. Pletcher, Hemisphere Publishing Corporation.

3. Computational Fluid Flow and Heat Transfer: K. Muralidhar and T. R. Sundararajan, Narosa Publishing House.

4. Computational Methods in Engineering: S. P. Venkateshan and P Swaminathan, Ane Books Pvt Ltd.