Course Type	Course Code	Name of the Course	L	T	P	Credits
DC	NESC508	Numerical Methods for Environmental Application	3	1	0	4

Course Objectives

To understand the fundamental concepts of numerical methods for solving engineering problems, and provide the basic idea of MATLAB/Python programming for environmental problems.

Overall Learning Outcomes

Upon successful completion of this course, students will be able to:

- Apply different numerical methods to solve the engineering problems.
- Use MATLAB/Python programing for numerical methods and environmental problems.

Unit No.	Topics to be covered	Contact Hr (L+T)	Learning outcomes
I	**Introduction to Programming:** Basics of MATLAB/Python programming, Matrices in MATLAB/Python, Basic Matrix Operations, Array operations, Loops and Execution Control, Working with Files: Scripts and Functions and Plotting and Program Output.	8+2	Introduction to Programming: Basics of MATLAB/Python programming, Matrices in MATLAB/Python, Basic Matrix Operations, Array operations, Loops and Execution Control, Working with Files: Scripts and Functions and Plotting and Program Output.
II	**Approximations and Errors:** Defining Errors and Precision in Numerical Methods, Truncation and Round-off Errors, Error Propagation.	4+2	Understanding the concepts of errors in numerical analyses.
III	**Systems of Linear Algebraic Equations:** Elimination Methods: Gauss Elimination and Gauss-Jordan Elimination, LU Factorization, Thomas Algorithm for Tridiagonal Systems of Equations, Pitfalls of Elimination Methods, Iterative Methods: Jacobi, Gauss-Seidel and Successive-Over-Relaxation (SOR)	7+2	Students will learn to use the elimination and iterative methods to solve the system of linear algebraic equations
IV	**Nonlinear Equations:** Closed Domain Methods, Open Domain Methods, Polynomial Deflation, Newton-Raphson Method for Multiple Roots, Systems of Non-Linear Algebraic Equations, Newton-Raphson Method for Two Coupled Nonlinear Equations	6+2	Students will be able to use the closed and open domain methods for solving the nonlinear equations.
V	**Polynomial Approximation and Interpolation:** Direct Fit Polynomials, Lagrange Polynomials, Interpolation, Difference Tables and Difference Polynomials, Inverse Interpolation, Cubic Splines, Least Squares Approximation: Straight Line approximation, Quadratic and Multivariate Polynomial Approximations	7+2	This unit covers the different methods for fitting a polynomial to a discrete set of data.
VI	**Numerical Differentiation and Integration** Numerical Differentiation: Newton Forward-Difference Polynomial, Newton Backward-Difference Polynomial, Numerical Integration: Newton-Cotes Formulas, Gaussian Quadrature	5+2	To illustrate numerical differentiation and integration methods for a discrete set of data.
VII	**Applications of MATLAB/Python** Programing of Numerical Methods, Use of MATLAB/Python in Environmental Problems (Case Studies)	5+2	To use MATLAB/Python for solving environmental problems
Total		42+14	

Text Books:

1. Chapra, S. C., and Canale, R. P. (2006). Numerical Methods for Engineers, 5th Ed., McGraw Hill
2. Hoffman, J. D. (2001). Numerical Methods for Engineers and Scientists, 2nd Ed., Taylor & Francis Group

Reference books:

1. Fausett, L.V. (2007). Applied Numerical Analysis Using MATLAB, 2nd Ed., Pearson Education
2. Lubanovic, B. (2014). Introducing Python: Modern Computing in Simple Packages, O'Reilly Media, Inc.
3. Urban, M., and Murach, J. (2016). Murach's Python Programming, Shroff Publishers & Distributors Pvt. Ltd.

4. Yang W. Y., Cao W., Chung, T-S., and Morris J. (2005). Applied Numerical Methods Using MATLAB, John Wiley & Sons, Inc.
5. Guha S., and Srivastava R. (2010). Numerical Methods for Engineering and Science, Oxford University Press, New Delhi.
6. Pratap, R. (2010). Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, Oxford University Press, Inc.