

Course Code	Course Name	Credits
26PH503	NUMERICAL METHODS AND PROGRAMMING	04

### Course Objectives

- To understand different types of computational errors and apply error analysis techniques in numerical methods.
- To learn numerical techniques for solving linear and nonlinear algebraic equations.
- To apply numerical methods for differentiation, integration, and solving ordinary differential equations.
- To develop programming skills using structured approach and fundamentals of C programming.
- To implement numerical algorithms using C programming for solving real-world scientific problems.

### Learning Outcomes

After completion of the course, students will be able to:

- Describe the capabilities and limitations of computational methods in physics;
- Identify and describe the characteristics of various numerical methods;
- Establish tactics for encapsulating and hiding complexity;
- Independently program computers using leading-edge tools;
- Formulate and solve computationally a selection of problems in physics

### Unit 1 - Computations Errors And Measurements (12 Hrs.)

Errors in computation: Types of errors: random errors, approximation errors, roundoff errors, model for round off error accumulation. Data fitting: Lagrange interpolation and least squares fit methods, specific example of fitting experimental data on exponential decay, goodness of fit. Error analysis: Estimation of errors in the numerical integration and differentiation.

### Unit 2 – Linear And Non Linear Equations (12 Hrs.)

Simultaneous linear equations: Gauss elimination method-Jordon's modification- Inverse of a matrix by Gauss-Jordon method-roots of nonlinear equations: Bisection and Newton Raphson method- Gauss-Seidel iterative method – Eigen values and eigenvectors of a real symmetric matrix by Jacobi's method – Determination of largest eigen value by Power method.

### Unit 3 - Integration, Differentiation And Solution Of Differential Equations (12 Hrs.)

Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's rule – Error estimates – Gauss-Legendre, Gauss-Laguerre, Gauss-Hermite and Gauss-Chebyshev quadrature – solution of ordinary differential equations – Euler and Rungakutta methods.

### Unit 4 – Program Basics (12 Hrs.)

Introduction to structured approach to programming, Flow chart - Algorithms, Pseudo code - Character set, Tokens, Identifiers in C, Variables and Data Types, Constants, Console IO Operations, printf and scanf - Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator, size of operator, Assignment operators and Bitwise Operators. Operators Precedence - If Statement, Switch Statement, Unconditional Branching using go to statement, While Loop, Do While Loop, For Loop, Break and Continue statements.

### Unit 5 - Programming With C (12 Hrs.)

Integer and floating point arithmetic expressions- programs for the following computational methods: (a) Zeros of polynomials by the bisection method, (b) Zeros of polynomials/non-linear equations by the Newton-Raphson method, (c) Newton's forward and backward interpolation, Lagrange interpolation, (d) Trapezoidal and Simpson's rules, (e) solution of first order differential equations by Euler's method.

### Reference Books:

1. S.D. Conte and C.Boor, Elementary Numerical Analysis, Third Edition, McGraw Hill, Singapore (1981).
2. B.H. Flowers, An Introduction to Numerical methods in C++, Oxford University Press, Oxford (2009).
3. V. Rajaram, Programming in C, Prentice - Hall of India, New Delhi (1994).
4. E. Balagrusamy, Numerical methods, Tata McGraw Hill, New Delhi (1999).
5. Computational physics, problem solving with computers, Rubin H Landau, Manuel J Paez, and Cristian C Bordeianu, Wiley, 2007.
6. Numerical Methods, MPHSEL, Department of Physics, School of Science, Tamil Nadu Open University

### Websites and eLearning Sources:

1. [https://onlinecourses.nptel.ac.in/noc21\\_ma45/preview](https://onlinecourses.nptel.ac.in/noc21_ma45/preview)
2. <https://youtu.be/fROf2j2SoYQ?si=JdJy0vGIWMfQPJCl>
3. [https://youtu.be/PIPIv6gn\\_Ls?si=CwfpsrMRqHLAGEqN](https://youtu.be/PIPIv6gn_Ls?si=CwfpsrMRqHLAGEqN)

**COs and Bloom's Taxonomy Mapping – 26PH503**

<b>Course Outcomes</b>	<b>On successful completion of this course, students will be able to</b>	<b>BTL</b>
<b>CO1</b>	Recall numerical methods, computational errors, and programming basics.	K1, K2
<b>CO2</b>	Apply numerical techniques to solve algebraic and differential equations.	K3
<b>CO3</b>	Analyze numerical methods for accuracy and efficiency in computations.	K4
<b>CO4</b>	Evaluate different computational approaches for solving physics problems.	K5
<b>CO5</b>	Develop programs to model and simulate physical systems numerically.	K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

**Relationship Matrix – 26PH503**

<b>Course Outcomes</b>	<b>Programme Outcomes (POs)</b>						<b>Programme Specific Outcomes (PSOs)</b>						<b>Mean Score of Cos</b>
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>	<b>PSO6</b>	
<b>CO1</b>	2	2	1	1	2	1	2	2	1	1	2	1	1.67
<b>CO2</b>	3	3	2	2	2	1	2	3	2	2	2	1	2.08
<b>CO3</b>	3	3	3	2	2	1	2	3	3	2	2	2	2.33
<b>CO4</b>	3	3	3	2	2	2	2	3	3	2	3	2	2.50
<b>CO5</b>	3	3	3	3	3	2	3	3	3	3	3	2	2.75
<b>Total</b>													2.27

Mean Score: 3- High, 2- Medium/Moderate, 1-Low

