PG MA S4-01 (DSC)

TWO YEAR MASTER'S DEGREE COURSE

(CBCS in Accordance with NEP 2020)

SEMESTER - IV

NUMERICAL ANALYSIS AND COMPUTATION

MATHEMATICS

Hiranya Chandra Bhuyan School of Science and Technology

KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY

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COURSE INTRODUCTION

"**Numerical Analysis and Computation**" is a Discipline-Specific Core (DSC) course offered in the fourth semester of the M.Sc. Mathematics programme.

This course introduces learners to numerical techniques for solving algebraic equations, interpolation problems, differential equations, integration problems, and matrix equations with the help of computational algorithms and programming methods.The course emphasizes both the theoretical foundations and practical computational aspects of numerical methods. It also introduces computer-oriented algorithms using the C programming language for implementing numerical techniques efficiently.

The course is organized into the following units:

Unit 1: Error Analysis and Numerical Computations

This unit introduces the fundamental concepts of numerical computation and error analysis. Learners will study approximate numbers, significant figures, rounding of numbers, and different types of errors. The unit also explains computer representation of numbers, floating-point arithmetic, propagation of errors, and loss of significant digits, which are essential for understanding the accuracy and stability of numerical computations.

Unit 2: Interpolation

This unit discusses interpolation methods used to estimate unknown values from known data points. Topics include Lagrange interpolation, Newton divided difference interpolation, Gregory-Newton backward interpolation, central interpolation, and Hermite interpolation. These methods are widely used in data approximation and numerical modeling.

Unit 3: Spline Interpolation

This unit introduces spline interpolation techniques, particularly quadratic and cubic spline interpolation. Splines provide smooth approximations to functions and are useful in computer graphics, curve fitting, engineering design, and scientific data analysis.

Unit 4: Solution of Transcendental and Polynomial Equations

This unit focuses on numerical methods for finding roots of equations. Learners will study iterative methods such as the Bisection method, Iteration method, Regula-Falsi method, Secant method, and Newton-Raphson method. The unit also discusses methods for determining roots of polynomial equations.

Unit 5: Interpolation (With Equal Intervals)

This unit deals with interpolation formulas applicable when data points are equally spaced. Topics include Newton's forward interpolation formula, backward interpolation formula, and central-difference interpolation methods. These techniques are useful in numerical approximation and table computations.

Unit 6: Interpolation (With Unequal Intervals)

This unit introduces interpolation methods for unequally spaced data points. Learners will study Lagrange's interpolation formula, divided differences, and Hermite's interpolation formula, which are important for practical applications involving irregular data.

Unit 7: The Accuracy of Interpolation Formulas

This unit discusses the accuracy and error analysis of interpolation formulas. It explains polynomial approximation errors and remainder terms associated with Newton's forward, backward, Stirling's, and Lagrange interpolation formulas. This helps learners understand the reliability of interpolation techniques.

Unit 8: Numerical Differentiation

This unit introduces numerical methods for differentiation. Learners will study techniques for approximating derivatives of functions, especially when function values are unequally spaced. Numerical differentiation is useful in engineering computations and scientific simulations.

Unit 9: Numerical Integrations

This unit focuses on numerical integration or quadrature methods used to approximate definite integrals. Topics include the trapezoidal rule, Simpson's rules, Newton-Cotes formulas, and quadrature formulas for equally spaced arguments. These methods are widely applied in scientific and engineering calculations.

Unit 10: Numerical Solution of Ordinary Differential Equations

This unit introduces numerical methods for solving ordinary differential equations (ODEs). Methods such as Picard's method, Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta method, Predictor-Corrector methods, and Adams-Bashforth method are discussed. These techniques are essential for modeling physical and engineering systems.

Unit 11: Solution of Simultaneous Algebraic Equations

This unit deals with numerical methods for solving systems of linear equations. Learners will study Gauss elimination, LU decomposition, Jordan's method, Jacobi method, and Gauss-Seidel method. The unit also discusses ill-conditioned systems of equations and computational challenges associated with them.

Unit 12: Numerical Solution of Partial Differential Equations

This unit introduces finite-difference methods for solving partial differential equations (PDEs). Topics include finite-difference approximations, Laplace equation, one-dimensional heat equation, and wave equation. These methods are important in mathematical physics, engineering, and computational science.

Unit 13: Numerical Algorithm in C-I

This unit focuses on the implementation of numerical algorithms using the C programming language. Learners will develop computer codes for methods such as the Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method, Newton forward interpolation, and Newton backward interpolation.

Unit 14: Numerical Algorithm in C-II

This unit continues the computational implementation of numerical techniques in C programming. Topics include coding for the trapezoidal method, Simpson's method, Gauss elimination method, Gauss-Jordan method, Gauss-Seidel method, and Jacobi method. The unit emphasizes practical computational skills and algorithmic efficiency.

Each unit includes some along-side boxes to help you know some of the difficult, unseen terms. Some "EXERCISES" have been included to help you apply your own thoughts. You may find some boxes marked with: "LET US KNOW". These boxes will provide you with some additional interesting and relevant information. Again, you will get "CHECK YOUR PROGRESS" questions. These have been designed to self-check your progress of study. It will be helpful for you if you solve the problems put in these boxes immediately after you go through the sections of the units and then match your answers with "ANSWERS TO CHECK YOUR PROGRESS" given at the end of each unit.