

## Numerical Analysis

|               |   |              |           |                |      |
|---------------|---|--------------|-----------|----------------|------|
| Credit Hours: | 3 | Course Code: | MATH-3116 | Prerequisites: | None |
|---------------|---|--------------|-----------|----------------|------|

**Course Introduction:** This course covers numerical techniques for solving mathematical problems, including error analysis, root-finding methods, and numerical solutions of linear systems. Topics include interpolation, numerical differentiation, and integration techniques such as Newton-Cotes and Gaussian quadrature. Emphasis is placed on computational accuracy, efficiency, and practical applications.

**Course Learning Outcomes:** Upon successful completion of this course, a student should be able to:

**CLO1:** Discuss Floating Point arithmetic.

**CLO2:** Solve linear systems using computer software.

**CLO3:** Explain mathematical reasoning in algorithms.

**CLO4:** Develop error analysis of numerical methods.

**PLO/CLO Mapping:**

|      | PLO1 | PLO2 | PLO3 |
|------|------|------|------|
| CLO1 | ✓    |      |      |
| CLO2 | ✓    | ✓    |      |
| CLO3 | ✓    | ✓    |      |
| CLO4 | ✓    | ✓    | ✓    |

**Course Contents:** Error analysis: Floating point arithmetic, approximations and errors and its types. Methods for the solution of nonlinear equations: Bisection method, regula falsi method, fixed point iteration method, Newton-Raphson method, secant method, error analysis for iterative methods. Numerical solution of a system of linear equations: Direct methods: Gaussian elimination method, Gauss-Jordan method; matrix inversion; LU factorization; Doolittle's, Crout's and Cholesky's methods, Iterative methods: Jacobi, Gauss-Seidel and SOR. Interpolation and polynomial approximation: Newton's divided difference formula, forward, backward and centered difference formulae, Lagrange interpolation, Newton's interpolation Formula, interpolation with a cubic spline, Hermite interpolation, least squares approximation, Error Term in Interpolation Formula. Numerical differentiation:

Forward, backward and central difference formula, Richardson's extrapolation. Numerical integration: Rectangular rule, trapezoidal rule, Simpson's 1/3 and 3/8 rules, Boole's and Weddle's rules, Newton-Cotes formulae, Gaussian quadrature.

**Recommended Books:** Following are the recommended books.

1. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Singapore, 2005.
2. R. L. Burden and J. D. Faires: Numerical Analysis, latest edition, PWS Pub. Co.
3. J.H. Mathews, Numerical Methods for Mathematics, latest Edition, Prentice Hall International. S. C. Chapra and R. P. Canale: Numerical Methods for Engineers, 6th edition, McGraw Hill.
4. W. E. Boyce, R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, John Wiley & Sons, Inc., 2001.
5. L. Debnath, Nonlinear Partial Differential Equations for Scientists and Engineers, Birkhauser-Boston, 2005.
6. Alexander Komech, Andrew Komech, Principles of Partial
7. Differential Equations, Springer-New York, 2009.
8. H. Richard, Elementary Applied Partial Differential Equations, Prentice-Hall International, Inc., London 1987.
9. Weinberger, Hans F., A First Course in Partial Differential Equations with Complex Variables and Transform Methods, Dover Publications, Inc., 1995.
10. R. Kent Nagle, Edward B. Sa, Arthur David Snider, Fundamentals of Differential Equations, Addison Wesley Longman, Inc., 2000