Under-Graduate Programme with MATHEMATICS; 5th Semester

MATHEMATICS **MAJOR COURSE**
MMT526J2: NUMERICAL METHODS **Credits: 6 (4-Th + 2-Pr)**
Theory: 4 Credits (60 Hours) **Practical/Internship: 2 Credits (60 Hours)**

Course Objectives: To understand role of mathematics in various disciplines, modelling real life situations. The objective of this course is to acquaint students with various analytical and numerical methods of finding solution of different type of problems, which arises in different branches of physics, chemistry, biology, humanities, social science etc.

Course Outcome: Students can handle physical and abstract problems to find an exact or approximated solutions. After getting trained a student can opt for advance courses in Applied Mathematics, Numerical analysis in higher mathematics.

Theory: 4 Credits

Unit- I

Introduction to numerical methods: need for numerical techniques, sources of errors, concept of approximation and convergence. Errors: absolute, relative, round-off, and truncation errors; rate of convergence. Numerical solution of nonlinear equations: Bisection method, Fixed-point iteration method, Newton–Raphson method. Polynomial interpolation: Lagrange interpolation and Newton's divided difference interpolation.

Unit – II

Finite difference operators: forward, backward, central, and averaging operators. Forward and backward difference interpolation. Spline interpolation. Numerical integration: basic quadrature rules, trapezoidal rule, Simpson's $\frac{1}{3}$ rule, Simpson's $\frac{3}{8}$ rule.

Unit – III

System of linear equations: Direct methods: Gauss elimination method, Gauss–Jordan method. Iterative methods: Jacobi method and Gauss–Seidel method, Conditions for convergence of iterative methods, Definition of eigenvalues and eigenvectors, Power method for finding dominant eigenvalue and corresponding eigenvector, Introduction to inverse power method.

Unit – IV

Numerical methods for ordinary differential equations (ODEs): Euler's method and Modified Euler's method. Runge–Kutta method of order 2 and order 4. Finite difference method for simple boundary value problems. Introduction to partial differential equations (PDEs): Basic finite difference schemes for heat equation.

Practicals/Internship: 2 Credits
Internship can be done in any other college where computational facilities are available.

Unit – V

Introduction to Python: Printing output, variables, simple arithmetic, Use of if condition, while loop, and for loop. Simple programs to:

- Compute **absolute and relative errors** for given values
- Implement **Bisection method (only 2–3 iterations manually coded)**
- Evaluate a polynomial using the **given interpolation formula (no general code)**
- Trapezoidal rule (for small number of intervals)
- Simpson's $\frac{1}{3}$ rule (simple case only)

Unit – VI

Simple programs to:

- Solve $\mathbf{2 \times 2}$ **system of linear equations** using direct formula
- Perform **one iteration of Jacobi method (no full loop required)**
- Find next value using **Euler's method (single step)**
- Compute one step of **Runge–Kutta (RK2 or RK4)**
- Basic use of lists/arrays for storing values

References

1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. S. S. Sastry, *Introductory Methods of Numerical Analysis*, PHI Learning Pvt. Ltd., New Delhi, 2012.
3. R. L. Burden and J. D. Faires, *Numerical Analysis*, Brooks/Cole, Cengage Learning, 2011.
4. K. E. Atkinson and W. Han, *Elementary Numerical Analysis*, Wiley India Pvt. Ltd., New Delhi, 2009.
5. Q. Kong, T. Siauw, and A. Bayen, *Python Programming and Numerical Methods: A Guide for Engineers and Scientists*, Elsevier, 2020.
6. Y. Liu, *First Semester in Numerical Analysis with Python*, Auraria Institutional Repository, 2020.

Note: The faculty members have a choice to conduct practical's of last two units (60 Hrs), or can offer internship (60 Hrs) from the College/University where the computational facilities are available.