COMPUTER BASED NUMERICAL METHODS

1. **Introduction**

Objective: To understand Computation and to make use the computers effectively for solving problems. Designing Flowcharts, algorithms for providing apt computation. Students are expected to have functions to provide solutions to numerical problems, which will be useful in their other courses as well as project works

Credits: 3-0-0

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

- Quantify absolute and relative errors.
- Distinguish between round-off and truncation errors.
- Interconvert binary and base-10 number representations.
- Define and use floating-point representations.
- Quantify how errors propagate through arithmetic operations.
- Implement the bisection method for solving equations.
- Implement both Newton-Raphson and secant methods.
- Perform basic matrix operations.
- Define and perform Gaussian elimination to solve a linear system.
- Identify pitfalls of Gaussian elimination.
- Define and perform Gauss-Seidel method for solving a linear system.
- Define and identify special types of matrices.
- Use LU decomposition to find the inverse of a matrix.
- Define and perform singular value decomposition; explain the significance of singular value decomposition.
- Define interpolation.
- Define and use direct interpolation to approximate data and find derivatives.
- Define and use Newton's divided difference method of interpolation.
- Define and use Lagrange and spline interpolation.
- Derive and apply the trapezoidal rule and Simpson's rule of integration.
- Distinguish Simpson's method from the trapezoidal rule.
- Estimate errors in trapezoidal and Simpson integration.
- Derive and apply Romberg and Gaussian quadrature for integration.
- Investigate how step size affects accuracy in Euler's method.
- Implement and use the Runge-Kutta 2nd order method for solving ordinary differential equations.

2. **Prerequisites**

Finite representation of numbers, Flowchart, exposure to algorithms, Real Analysis, one of the programing Languages.

3. **Course Outline**

UNIT - I: Transcendental and Polynomial equations
UNIT - II: System of Linear Algebraic equations and eigenvalue problems
UNIT - III: Interpolation and Approximation
UNIT - IV: Differentiation and Integration
UNIT - V: Ordinary differential equations

4. **Reading Material**

Text Books

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain (1993) "Numerical Methods for Scientific and Engineering Computation" Wiley Eastern Limited

References

1. Erwin Kreyszig (1993) "Advanced Engineering Mathematics" Wiley
2. Press, Teukolsky, Vellerling and Flannery (1992) "Numerical Recipes in C - the Art of Scientific Computing" Cambridge
3. Abromowitx and Stegum (1972) "Handbook of Mathematical Functions with formulas, Graphs and Methematical Tables" National Bureau of Standards Applied Mathematics Series . 55 Siperintendent of Documents U.S. Government Printing Office Washington, DC 20402
4. Jaan Kiusalaas (2009) " Numerical Methods in Engineering with MATLAB" Cambridge University Press (http://mhbb2012.persiangig.com/.uxdhABZETd/Numerical%20Methods%20in%20Engineering%20with%20MATLAB,%202nd%20Edition%20Sep%202009.pdf)

Note: Recommended to use MATLAB for Demos explaining/visualizing the concepts