Approval: 10th senate meeting

Course Name	: Numerical Analysis
Course Number	: MA-523
Credit	: 3-1-0-4
Prerequisites	: NA
Students intended for	: M.Sc. /M.S./Ph.D. /B.Tech. 3rd and 4th year
Elective or core	: Core for M.Sc. in applied Mathematics and Elective for other discipline.
Semester	: Odd/Even

Preamble:

The course emphasizes the effective use of numerical analysis in applications require both a theoretical knowledge of the subject and computational experience with it. The theoretical knowledge should include an understanding of both the original problem being solved and of the numerical methods for its solution, including their derivation, error analysis and an idea of when they will perform well or poorly. Finally the primary objective of the course is to develop the basic understanding of the numerical methods and perhaps more importantly, the applicability and limits of their appropriate use.

Course Outline:

The intended outcomes are:

1. To understand the Potential pitfalls of numerical computations.
2. Able to solve a big system of linear equations.
3. Able to determine the roots of nonlinear equations.
4. Able to construct the interpolating polynomial.
5. Able to get the numerical solutions of Initial and boundary value problem.

Course Modules:

Unit 1: Computer arithmetic, Kind of errors in Numerical Procedures, Significant digits, Backward error analysis, Sensitivity and conditioning, Stability and accuracy, Evolution of polynomials. [3 contact hours]

Unit 2: Nonlinear Equations: Bisection method, Secant method, Newton's method, Method of False-position, Secant method, Fixed point iterations, order of convergence, Newtons method for multiple roots, Newtons methods and fixed point method for the system of nonlinear equations. [6 lecture hours]

Unit 3: Existence and uniqueness of interpolating polynomial, Lagrange polynomials, Divided differences, Evenly spaced points, Error of interpolation, Piecewise interpolation, Cubic spline, Least-Square approximations. [7 lecture hours]

Unit4: System of linear equations: Gaussian elimination, Partial Pivoting, Pivoting and Scaling in Gaussian Elimination method , Singular matrices, Determinants and Matrix inversions, Tridiagonal systems, Norms, Condition numbers and errors in solutions; Iterative methods: Jacobi, Gauss-Seidel and SOR Methods, Power method, Inverse power method and QR methods for finding the eigenvalues and eigenvectors of matrices. [11 lecture hours]

Unit 5: Numerical Differentiation and Integration: Numerical differentiation, Newton-Cotes integration formulae, Composite rules, Error terms for Newton - Cotes formulae and composite rules, Methods of undetermined parameters, Gaussian quadrature. [5 lecture hours]

Unit 6: Initial and Boundary Value Problem (IVP & BVP): Taylor series method, Forward Euler, Backward Euler and Modified Euler methods, Runge-Kutta methods; Multistep methods: Milne's method, Adams-Moulton method, System of equations and Higher order equations, Stiff equations, Finite difference methods and Shooting methods for the Boundary vaue problems. [10 lecture hours]

Texts Books:

1. K. E. Atkinson, An Introduction to Numerical Analysis, 2nd Edition, John Wiley, 2008.
2. Numerical Analysis, R. L. Burden and J. D. Faires, 7th ed., Thomson Learning, 2001.

References:

1. M. T. Heath, Scientific Computing: An Introductory Survey, McGraw Hill, 2002.
2. Brian Bradie, A friendly introduction to Numerical Analysis , Pearson Education, 2007.