# Numerical Methods

**Total marks:** 150(Theory: 75, Practical: 50, Internal Assessment: 25)
**5 Periods** (4 lectures +1 students' presentation),
**Practical** (4 periods per week per student),
Use of Scientific Calculators is allowed.

## (1st Week)

Floating point representation and computer arithmetic, Significant digits, Errors: Round-off error, Local truncation error, Global truncation error, Order of a method, Convergence and terminal conditions, Efficient computations

*Sections* 1.2.3, 1.3 (Pages 16 to 25 and Page 30) [1]

## (2nd Week)

Bisection method, Secant method, Regula–Falsi method

*Sections* 2.1, 2.2 [1]

## (3rd Week)

Newton–Raphson method, Newton's method for solving nonlinear systems

*Sections* 2.3, 7.1.1(Pages 266 to 270) [1]

## (4th Week)

Gauss elimination method (with row pivoting) and Gauss–Jordan method, Gauss Thomas method for tridiagonal systems

*Sections* 3.1 (Pages 110 to 115), 3.2, 3.3 [1]

## (5th Week)

Iterative methods: Jacobi and Gauss-Seidel iterative methods

*Sections* 6.1 (Pages 223 to 231), 6.2 [1]

## (6th Week)

Interpolation: Lagrange's form and Newton's form

*Sections* 8.1 (Pages 290 to 299 and Pages 304 to 305) [1]

## (7th Week)

Finite difference operators, Gregory Newton forward and backward differences Interpolation

*Sections* 4.3, 4.4 (Pages 235 to 236) [2]

## (8th Week)

Piecewise polynomial interpolation: Linear interpolation, Cubic spline interpolation (only method), Numerical differentiation: First derivatives and second order derivatives, Richardson extrapolation

*Sections* 16.1, 16.2 (Pages 361 to 363), 16.4 [3]
*Section* 11.1 (Pages 426 to 430 and Pages 432 to 433) [1]

## (9th Week)

Numerical integration: Trapezoid rule, Simpson's rule (only method), Newton–Cotes open formulas

*Sections* 11.2 (Pages 434 to 445) [1]

## (10th Week)

Extrapolation methods: Romberg integration, Gaussian quadrature, Ordinary differential equation: Euler's method

*Sections* 11.2.4, 11.3.1 [1]
*Section* 20.2 (Pages 481 to 485) [3]

## (11th Week)

Modified Euler's methods: Heun method and Mid-point method, Runge-Kutta second methods: Heun method without iteration, Mid-point method and Ralston's method

*Sections* 20.3, 20.4 (Pages 493 to 495) [3]

## (12th Week)

Classical 4th order Runge-Kutta method, Finite difference method for linear ODE

*Section* 20.4.2 [3]
*Section* 14.2.1 [1]

# PRACTICALS

1. Find the roots of the equation by bisection method (Exercises P2.1 to P2.20 [1])
2. Find the roots of the equation by secant/Regula–Falsi method (Exercises P2.1 to P2.20 [1])
3. Find the roots of the equation by Newton's method (Exercises P2.11 to 2.29 [1])
4. Find the solution of a system of nonlinear equation using Newton's method (Exercises P7.1 to P7.15 [1])
5. Find the solution of tridiagonal system using Gauss Thomas method (Exercises P3.21 to P3.25, C3.1 to C3.3, A3.7, A3.8[1])

6. Find the solution of system of equations using Jacobi/Gauss-Seidel method (Exercises P6.1 to P6.18 [1])
7. Find the cubic spline interpolating function (Exercises C8.1 to C8.5 [1])
8. Evaluate the approximate value of finite integrals using Gaussian/Romberg integration (Exercises P11.6 to P11.20 [1])
9. Solve the initial value problem using Euler's method and compare the result with the exact solutions (Exercises P12.11 to P12.20 [1])
10. Solve the boundary value problem using finite difference method (Exercises P14.1 to P14.25 [1])

Note: Programming is to be done in any one of Computer Algebra Systems: MATLAB/MATHEMATICA/MAPLE.

## **REFERNCES**:

[1] Laurence V. Fausett, Applied Numerical Analysis, Using MATLAB, Pearson, 2/e (2012)

[2] M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publisher, 6/e (2012)

[3] Steven C Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata McGraw Hill, 2/e (2010)