Advanced Computational Techniques (RP 4.2.14)

Matrix Parameters: Inverse, Rank, Trace, Adjoint; Eigenvalues and Eigenvectors; Straight and LU decomposition; Gauss-Seidal iteration, ill condition, pivoting. [4]

Finite Difference and Interpolation: Difference operator, Shift operator, Central Difference operator, Averaging operator; Interpolation and differentiation using Divided Difference for equally spaced data points - Newton's interpolation, Gauss's Central Difference interpolation schemes, error estimation; Interpolation and differentiation for unequally spaced data points - Lagranges interpolation, interpolating polynomial and spline interpolation; error estimation. [5]

Integration: Algorithm for tabulated function – using Trapezoidal, Simpson's rules for equally spaced data points and using methods of splines for unequally spaced data points; Algorithm for known function – using Trapezoidal, Simpson's rules and Gauss quadrature methods along with modifications by Lobatto and Tchebycheff [4].

Ordinary Differential Equations (ODE) :: Initial Value (IV) problems: Euler's method and Modified Euler's method; Predictor-Corrector method, Runge-Kutta 2nd order – Heun's and Polynomial Methods; Runge-Kutta 3rd and 4th orders; [4]

Ordinary Differential Equations (ODE) :: Boundary Value (BV) & EigenValue (EV) problems: Finite Difference Equations (FDE) - its numerical solutions by shooting method, else by adopting techniques to evaluate eigenvalues and eigenvectors. [4]

Partial Differential Equations (PDE): Finite Difference equations (FDE); Elliptic (Laplace / Poisson) equations; Parabolic and Hyperbolic equations. [6]

Computational Statistics [4]
Review of probability theory and common distributions, sampling terminology and concepts, parameter estimation and error concepts, confidence interval, generation of continuous and discrete random variables, Monte Carlo simulation. Curve Fitting/Functional Approximation, least square polynomial approximation, applications

Optimization Theory [5]
Optimal problem formulation, Multivariable optimization techniques: direct search and gradient-based method, constrained optimization problem formulation, stochastic global search optimization algorithms, applications