

Final exam questions 2024

Applied numerical methods with Matlab

Students must know the construction of the methods, the statements and definitions related to them and should also be able to solve short problems. Proofs of the theorems are not required.

1. Basic concepts of numerical analysis: Vector and matrix norms, relations between the norms and the spectral radius, floating point numbers, convergence order of sequences.
 2. Direct solution methods of linear systems of equations: Gaussian elimination, LU decomposition, condition number of matrices, estimate for the relative change of the solution. Cholesky factorization.
 3. Iterative methods of linear systems: Jacobi and Gauss-Seidel iterations, relaxation, convergence of the iteration, error estimation with Banach's fixed point theorem.
 4. QR decomposition: Givens rotations and Householder reflections, QR decomposition, solution of over-determined systems.
 5. Eigenvalue problems: Gershgorin's theorem, power method, inverse iteration, QR iteration.
 6. Solution of nonlinear equations: bisection method, Newton method, fixed point iteration.
 7. Interpolation with polynomials: Lagrange and Newton interpolation formulas, interpolation error.
 8. Numerical differentiation: forward, backward, and centered formulas, convergence order, Richardson's extrapolation.
 9. Numerical integration: Newton-Cotes formulas and their usage, Gaussian quadrature. Convergence and exactness order.
 10. Numerical solution of ordinary differential equations I: Euler methods, Crank-Nicolson method, Runge-Kutta methods.
 11. Numerical solution of ordinary differential equations II: Basic terms of one-step methods, stability, consistency, convergence, stiff problems. Numerical solution of boundary value problems: the shooting method.
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