

MATH 273: TOPICS for Midterm Exam II

1 ALGORITHMS:

Primary:

1. LU-factorization by Gaussian elimination with pivoting, forward and back substitution to solve triangular systems
2. Set up linear least squares problem as overdetermined linear system.
3. Solve linear least squares problems using QR factorization, computed by Givens rotations
4. Bisection, Newton, secant, inverse quadratic interpolation for nonlinear equations, finite difference derivatives
5. Golden section, Newton's method, parabolic interpolation for 1-D optimization
6. Steepest Descent, Newton's method, line search for multidimensional optimization
7. Newton method for systems of nonlinear equations and multidimensional optimization

Secondary:

1. Multiply matrix-vector and matrix-matrix
2. Row-oriented, column-oriented, saxpy versions of matrix algorithms
3. Make 2-D tables of function values, approximate double integrals
4. Cholesky factorization of symmetric positive definite tridiagonal matrix
5. Solve two-point boundary-value problems for linear D.E. by using tridiagonal system of difference equations.

Know what each algorithm is used for and how it works; be prepared to carry out the steps of an algorithm in simple cases.

2 ANALYSIS

1. Basic facts about linear systems
2. Vector and matrix norms
3. Conditioning of linear systems and least squares problems.
4. Equivalence of row operation and multiplication by elementary matrix.
5. Stability of Gaussian elimination, QR factorization (effect of roundoff).
6. Orthogonal matrices and their properties.
7. Efficiency - floating point operation counts for matrix algorithms.
8. Accuracy of computed solutions of linear systems, least squares problems and two-point boundary value problems.
9. Geometry of multivariate optimization (interpretation of gradient, Hessian, descent direction, quadratic model of function)
10. Geometry of nonlinear equations (Jacobian, linear model of a function)

Know what the analysis (presented in the book or in class) says about each of the algorithms above. Be prepared to apply that analysis in specific cases.

3 SOFTWARE

1. Vectorize!
2. Make contour plots
3. Use the backslash operator “\”
4. Use MATLAB commands `lu`, `qr`, `cond`, `condest`, `polyfit`, `polyval`, `fzero`, `fmin`, `fmins`, colon notation
5. Apply data structures for tridiagonal matrices, LU factors, permutation matrices
6. Construct rotation matrices with no inverse trig functions and no risk of overflow
7. Choose appropriate tolerances for iteration methods

Be familiar with the above computing concepts and MATLAB commands. Be prepared to deduce what a given fragment of MATLAB code does, and be able to modify or extend it to improve its efficiency or produce a required different result.

The exam is designed with the expectation that you have run all the MATLAB scripts from the text, as well as those provided by the instructor, and understood the results; and that you have solved the assigned Exercises from the textbook.