EE 636: Matrix Computations

Syllabus

- **Fundamentals:** Flops count, memory management, matrix-vector multiplication.
- **Gaussian elimination:** Basic Gaussian elimination without pivoting, LU decomposition, the condition of LU decomposability. Gaussian elimination with pivoting. Positive definite matrices, Cholesky factorization. Comparison between the two methods. A brief discussion on sparsity.
- **Sensitivity and round-off errors:** Vector norms, matrix norms. Condition number. Perturbation, residual, round-off errors. Backward stability. Error propagation in Gaussian elimination. Backward error analysis in Gaussian elimination.
- **QR decomposition:** Orthogonal matrices, rotators and reflectors. Solution of the least squares problem, the full-rank case. Gram-Schmidt process. Condensed QR decomposition. Updating the QR decomposition.
- **SVD:** Introduction. Algorithm. Applications. Sensitivity.
- **Eigenvalues and eigenvectors:** The power method. Unitary similarity transform, Schur's theorem, normal matrices, spectral theorem of normal matrices. Hessenberg and tri-diagonal matrices, reduction to these forms. The QR algorithm. A brief discussion on sparsity.
- **Iterative methods:** Steepest descent, conjugate gradient.

Textbooks

- **David S. Watkins**, *Fundamentals of Matrix Compuations*, 3rd Edition, Willey-Interscience, 2010.
- **Gene H. Golub and Charles F. Van Loan**, *Matrix Computations*, 4th Edition, The Johns Hopkins University Press, 2013.

Grading policy

- **Two quizzes:** $10\% + 10\%$.
- **Midsem:** 20%.
- **Endsem:** 50%.
- **Assignments and class performance:** 10%.