Numerical Methods I

Cross-listed as CSCI-GA.2420-001 and MATH-GA 2010-001 (2467)

Organization

- **Lecture**: MW, 04.55-6.10pm, WWH 1302
- **Instructor**: Benjamin Peherstorfer
- **Office hours:**
  - Instructor: Mondays, 6.10pm, WWH 421
  - Grader: Fridays, 2.30-3.30pm, WWH 803
- **Grader:** Qi (Winston) Liang, lq504@nyu.edu
- **Grading**: Homeworks (60%) + Final Exam (40%)
  - All homeworks will enter with equal weight, independent of the total number of points per homework
- **NYU Brightspace**
  - https://brightspace.nyu.edu/d2l/home/400947
  - If you audit the course and want to be added to the NYU Brightspace to access slides and homeworks, then send me an email with your NYU NETID or your NYU Directory email address
- **Homeworks (biweekly)**
  - Will be handed out on Mondays
  - Due 2 weeks after handed out before class; upload to NYU Brightspace
- **Recommended textbooks (not required)**:
  - Primary textbook: Deuflhard, P. and Hohmann, A., Numerical Analysis in Modern Scientific Computing, Springer-Verlag (2003). This book is freely available to you via the NYU library subscription.
  - Secondary textbook for numerical linear algebra: L.N. Trefethen and D. Bau, III, Numerical Linear Algebra, SIAM (1997), available for purchase. Also available as a reserve item at the Courant library.
  - Another textbook: Quarteroni, A., Sacco, R., & Saleri, F. (2006). Numerical Mathematics (2nd ed.) Texts in Applied Mathematics [Series, Bk. 37]. New York, NY: Springer-Verlag.
  - Textbook for floating-point arithmetic and conditioning: M. L. Overton, Numerical Computing with IEEE Floating Point Arithmetic, SIAM (2004). This book is freely available to you https://epubs.siam.org/doi/book/10.1137/1.9780898718072
- **Prerequisites**
  - A solid knowledge of undergraduate linear algebra and multivariable calculus and experience programming in MATLAB/Python.

Schedule

Note that the schedule below is only a guideline. The content of each lecture will be decided as the course progresses.

date	Monday
Week 1	09/02 Monday: Labor day 09/04 Wednesday: Organization; Overview of research on numerical methods at CIMS; Motivational examples; Conditioning of problems; Sources of errors
Week 2	09/09 Monday: Examples of conditioning, stability, convergence speed, IEEE number representations 09/11 Wednesday: Axioms of IEEE number representations, propagation of errors, numerical cancellation, Big O notation, Quick intro to Matlab
Week 3	09/16 Monday: Gauss/LU, pivoting 09/18 Wednesday: Solving linear systems, Cholesky, sparse matrices, solver libraries in Matlab
Week 4	09/23 Monday: Data fitting and linear least squares problems, normal equations, and conditioning problem 09/25 Wednesday: Gram Schmidt, QR factorization
Week 5	09/30 Monday: Eigenvalues and eigenvectors, conditioning, Power method and variants, 10/02 Wednesday: QR algorithm, SVD and its applications
Week 6	10/07 Monday: Trace estimation 10/09 Wednesday: Randomized power method
Week 7	10/14 Monday: No class 10/15 Tuesday: Iterative methods for solving (sparse) systems of linear equations, Jacobi 10/16 Wednesday: Gauss-Seidel
Week 8	10/21 Monday: Iterative methods: Relaxation methods 10/23 Wednesday: Conjugate gradient method
Week 9	10/28 Monday: Conjugate gradient method 10/30 Wednesday: Interpolation, polynomial bases

Week 10	11/04 Monday: Interpolation with splines, trigonometric polynomials 11/06 Wednesday: tbd
Week 11	11/11 Monday: Solution of nonlinear equations: Fixed points 11/13 Wednesday: Newton's method for system of equations, Gauss-Newton method
Week 12	11/18 Monday: Quadrature 11/20 Wednesday: Quadrature
Week 13	11/25 Monday: Sparse grids for high-dimensional quadrature and the need for multi-level hierarchies 11/27 Wednesday: tbd
Week 14	12/02 Monday: Sparse grids 12/04 Wednesday: Review and Q&A
Week 15	12/09 Monday: Review and Q&A 12/11 Wednesday: No class, Legislative Friday