Staff:

Instructor: Robert Skeel  
CS 164D  
49-49025  
skeel at cs.purdue.edu

Teaching Assistant: Huiying Xu  
Physics 178  
49-62779, 49-62780  
hxu at cs.purdue.edu

Office hours:

Mondays 10:00–11:00 am
Tuesdays 1:30–2:00 pm
Wednesdays 1:30–2:00 pm
Thursday 2:00–3:00 pm

Web page: The class web page is http://www.cs.purdue.edu/homes/skeel/cs515.html

Examination dates:
Wednesday, February 15, in class,
Wednesday, March 22, in class,
Wednesday, April 19, in class,
May 1–6, 2-hour exam.

Textbook: Textbook (recommended):

ITERATIVE METHODS FOR SPARSE LINEAR SYSTEMS, 2nd edition

supplemented by reasonably detailed instructor’s notes. Other good references:

- SCIENTIFIC COMPUTING: AN INTRODUCTORY SURVEY, 2nd edition

- LINEAR ALGEBRA AND ITS APPLICATIONS, 3rd edition by G. Strang.

- NUMERICAL METHODS by Dahlquist and Bjorck, Chapter five
  is a good condensation of much of this course.

- FUNDAMENTALS OF MATRIX COMPUTATIONS, 2nd edition by David Watkins,


• MATRIX COMPUTATIONS, 3rd edition by Golub and Van Loan is an up-to-date graduate-level textbook.

These books will be on reserve in the Mathematical Sciences Library.

Course outline

1. Direct methods, part I: linear systems of equations, norms, ill-conditioning, elimination, LU and Cholesky factorization. (6 lectures)

2. Direct methods, part II: rounding error, interval analysis, numerical instability, pivoting, scaling, iterative improvement. (5 lectures)

3. Least squares problems: normal equations, QR factorization, Householder reflections, Givens rotations, Gram-Schmidt orthogonalization, SVD. (4.5 lectures)

4. Eigenvalue problems: shifted inverse iteration, shifted QR iteration, reduction to upper Hessenberg form, Lanczos method, Jacobi method, bisection, computing the SVD. (4.5 lectures)

5. Sparse direct methods: banded, profile, and sparse storage, reordering, fast direct methods. (4 lectures)

6. Sparse iterative methods: stationary methods. (2 lectures)

7. Sparse iterative methods: projection methods. (2 lectures)

8. Sparse iterative methods: Krylov subspace methods. (6.5 lectures)

9. Sparse iterative methods: preconditioning. (4.5 lectures)

Policies

a. Evident collaboration is penalized in accordance with university rules and the instructor’s policy is to impose substantial penalties. This does not, of course, preclude some discussion when starting an assignment. However, the onus is on you to ensure that the collaboration is sufficiently limited that it is not evident in your work. Use of your work by another will be assumed to be done with your consent unless there is evidence to the contrary.

b. Excuses. Failure to attend an exam or failure to submit an assignment on time is recorded as a zero except when it is unavoidable because of some legitimate emergency (a medical excuse from a physician, or a death in the immediate family). In such a case it is desirable that the instructor be contacted before the exam or before the due date of the assignment.

Assignments

a. There will be about six assignments. Tentative due dates are Jan 27, Feb 10, Feb 24, Mar 10, Mar 31, and Apr 14.

b. Some will require the use of the computer. You may use Matlab, Python, or C. The first of these is particularly suited for the course. If your chosen language does not have builtin plotting, you can use, for example, gnuplot.
**Grading**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>assignments</td>
<td>36%</td>
<td>A</td>
<td>80–100%</td>
</tr>
<tr>
<td>hourly exams</td>
<td>36%</td>
<td>B</td>
<td>65–80%</td>
</tr>
<tr>
<td>final exam</td>
<td>28%</td>
<td>C</td>
<td>50–65%</td>
</tr>
</tbody>
</table>

The grade boundaries may be uniformly lowered by as much as 10% in order to achieve a reasonable grade distribution for undergraduates. Also, there may be minor upward or downward adjustments of the grade boundaries.

**Qualifying exam**  The qualifying exam for students from Computer Science will be at the same time as the 2-hour final plus one extra hour.