Memorial University of Newfoundland

Math 6204: Iterative Methods in Numerical Linear Algebra

Winter 2016 Course Outline

Classrooms & Times: C 2024 (MWF 14:00 - 14:50)

Instructor: Dr. Scott MacLachlan
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Office hours: Mondays 1-2pm, Fridays 10-11am
Other times are available by appointment

Website: Class information, assignments, and solutions will be available on my home page as PDF files. The URL is `http://www.math.mun.ca/~smaclachlan/math6204_W16/`

Objectives: This course is intended for graduate students in Mathematics, Computer Science, and other applied science and engineering disciplines where large linear systems arise in numerical simulations. We will discuss applicability of and fundamental limitations on direct methods, and explore several families of tools that lead to optimal iterative methods. The goal of this course is to provide students with the "building blocks" of iterative methods, in order for them to use such methods in practical situations.

Prerequisites: Undergraduate linear algebra at the level of MATH2051, experience with programming (Matlab or Python preferred), experience with computer simulation. Completion of Math 6210 and/or 6201 is certainly sufficient, but not strictly necessary.

Outline:

1. Sparse Direct Methods: Gaussian elimination, reordering schemes, nested dissection. (2 weeks)
2. Classical Iterative Methods: matrix splittings, incomplete factorizations. (2 weeks)
3. Polynomial and Krylov Methods: Krylov spaces, optimality and quasi-optimality properties (3 weeks)
4. Domain Decomposition Methods: classical and optimized Schwarz, overlapping and two-level methods (2 weeks)
5. Multigrid Methods: geometric multigrid, variational methods, algebraic multigrid (3 weeks)

Evaluation: Course grades will be composed of

- Assignments: 30%. One assignment every 2-3 weeks, including analysis and programming components. Assignments are to be turned in during class on the day that they are due. You are allowed one "freebie", in which you may turn in an assignment during the next class and still receive credit; otherwise, late assignments will not be marked. If you require a longer extension due to exceptional circumstances, please provide me with appropriate documentation and a suggested timeline for completing the work.

- Final project: 20%. A final project, on a topic of your choosing that is relevant to the course, is to be completed by the last day of classes. This includes both a written component (properly typeset, of about 10 pages) and a 10 minute oral presentation to be given on the last day of classes.
- Final exam: 50%. The final exam will be composed of both a written and oral component. The written component will be held from noon - 2pm on April 11, 2016, in HH3013. This will by followed by an oral exam covering materials related to the written exam.

Suggested Texts:

The following texts are either freely available online or as e-books through the library's existing subscriptions:

- Saad, Iterative methods for sparse linear systems, SIAM 2003
- Greenbaum, Iterative methods for solving linear systems, SIAM 1997
- Varga, Matrix iterative analysis, Springer 2000
- Elman, Silvester, & Wathen, Finite elements and fast iterative solvers with applications in incompressible fluid dynamics, Oxford University Press 2005
- Olshanskii & Tyrtyshnikov, Iterative methods for linear systems: theory and applications, SIAM 2014
- Briggs, Henson, & McCormick, A multigrid tutorial, SIAM 2000
- Dolean, Jolivet, & Nataf, An introduction to domain decomposition methods: algorithms, theory, and parallel implementation, SIAM 2015

Important Dates:

Thursday, January 21	Last day to add courses
Monday-Friday, February 22-26	Midterm Break, no classes
Thursday, February 25	Last day to drop courses without academic prejudice
Wednesday, April 6	Last day of lectures
Monday, April 11	Written Final Exam, HH3013, noon - 2pm