92.564 Numerical Linear Algebra Dr. Charles Byrne

Course Overview

Instructor: Charles Byrne

Overview: Matrices and linear algebra play increasingly important roles in a wide variety of applications, including optimization problems, statistical estimation, image and signal processing, radiation therapy, and many more. Often these applications require exact or approximate solutions of linear equations or inequalities. It is not uncommon for the matrices involved to be quite large, necessitating the use of iterative solution algorithms. This course focuses on the algebra, the applications, and the algorithms, beginning with an overview of the applications to be discussed in more detail later, followed by a survey of basic linear algebra, and concluding with a study of iterative solution methods.

Topics: Our topics from linear algebra include linear independence, bases, rank of a matrix, systems of linear equations and inequalities, the split-feasibility problem (SFP), eigenvectors and eigenvalues, singular-value decomposition (SVD), estimation of singular values of sparse matrices, discrete Fourier transformation, and conditioning. The applications we study include transmission and emission tomography, magnetic resonance imaging, intensity-modulated radiation therapy, and sensor array processing. The iterative algorithms we discuss include the algebraic reconstruction technique (ART), its multiplicative version, MART, simultaneous algorithms such as Landweber's method and the expectation maximization maximum likelihood (MLEM) algorithm, methods for solving the SFP, and the fast Fourier transform (FFT).

Grading: The grade for the course will be based entirely on submitted homework. There are numerous exercises in the text. Students will be encouraged to work on a reasonable number of these exercises, to be submitted at mid-term and again at the end of the course.

Required Text: The text for the course is available, as a pdf file, on my web site

http://faculty.uml.edu/cbyrne/cbyrne.html

under ALL COURSES and under BOOKS IN PROGRESS. The title of the text is *Applied and Computational Linear Algebra*. The version that will be used for the course will be made available before the course begins.

Prerequisites: This is a first-year course in the masters' degree program in mathematics. While not absolutely essential, some previous encounter with linear algebra or matrix theory will be helpful.