Aims

This module aims to provide a toolkit of modern techniques in applied linear algebra, which is at the heart of many scientific and technical calculations. As well as introducing algorithms, it aims to provide ways to evaluate their accuracy and efficiency, particularly where the data used are noisy. It will consist of a combination of background theory, practical applications (using Matlab) and case studies. Some previous exposure to mathematics (particularly linear algebra) and scientific programming will be useful, although we shall review the concepts required.

Syllabus

**Introduction:** Scientific computers, floating point arithmetic, floating point operation counts. Introduction to the MATLAB scientific computing package. (1 lecture).

**Convergence:** Vector and matrix norms. Condition number and sensitivity of matrix calculations to errors in data. Accuracy and stability of algorithms. (1 lecture).

**Direct methods for linear systems:** Gaussian elimination, LU factorisation, pivoting. Using Gaussian elimination to calculate determinants. (1 lecture).

**Special matrices:** symmetric, positive definite, banded, sparse. Cholesky and LDL<sub>T</sub> factorisation. (1 lecture).

**Iterative methods for linear systems:** Jacobi, Gauss–Seidel, SOR, preconditioning, conjugate gradient and advanced methods. The Google page rank. (1 1/2 lectures).

**Orthogonalisation:** Gram–Schmidt and modified Gram–Schmidt. (1 lecture).

**Finding eigenvalues:** power and inverse power methods, Gershgorin circle theorem, QR iteration. (1 lecture).

**Singular value decomposition and applications:** pseudo-inverse, pseudo-eigenvalues. Applications in image processing. (1 lecture).

**Further examples and applications:** Solution of linear ODEs, matrix exponential, pseudospectrum. (1 lecture).

**Solving nonlinear systems of algebraic equations:** Newton-type methods. (1 lecture).

Teaching and Assessment

**Contact Hours:** 3 lectures/tutorial per week

**Assessment:** 25% by class tests or other continuous assessment
75% by end of course 2-hour exam

**Resit Type:** exam for MSc

Content: 19 September 2013
By the end of the course, students should be able to:

- understand the problems of computer arithmetic
- use Matlab for linear algebra
- assess the accuracy of linear algebra algorithms
- assess the computational costs of linear algebra algorithms
- assess the efficiency of linear algebra algorithms