McGill University, Department of Mathematics and Statistics
Honours Applied Linear Algebra, MATH 247/Winter 2010

Instructor: Professor Michael Makkai
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Office hours: TBA
Assignment marker: TBA
Prerequisite: Vectors, Matrices and Geometry, MATH 133; or equivalent.

Textbook: Seymour Lipschutz: Linear Algebra., 3rd edition (preferable), Schaum Outline Series. McGraw-Hill Book Company.

The text is on reserve in the library.

Materials for the course: notes, assignments, answers to assignments, and a continuously updated NEWS posting, will be available at the site http://www.math.mcgill.ca/makkai ; click on MATH 247.

Catalog description of the course:

> "Matrix algebra, determinants, systems of linear equations.
> Abstract vector spaces, inner product spaces, Fourier series.
> Linear transformations and their matrix representations.
> Eigenvalues and eigenvectors, diagonalizable and defective [=non-diagonalizable] matrices, positive definite [symmetric, with positive eigenvalues] and semidefinite matrices.
> Quadratic and Hermitian forms, generalized eigenvalue problems, simultaneous reduction of quadratic forms.
> Applications."

The course will cover the subjects mentioned in the catalog description, although not in the order stated.

Course outline:

1. Matrix algebra, and subspaces of the standard spaces.
   Operations on matrices. Use of matrices for the solution of systems of linear equations. The standard spaces $\mathbb{R}^n$ ($n = 2,3,4,\ldots$), and their subspaces. The spaces attached to matrices. Basis and dimension. Determinants; Cramer's rule.

(*Remark:* Part 1. is essentially a review of material from MATH 133.)

2. The geometry of the standard spaces and their subspaces.
   Geometric vectors. Cartesian and oblique coordinate systems.
   Flats (affine subspaces): lines and planes as special cases of flats. The dot product; orthogonality. Distance between flats. The method of least squares.
   Linear transformations of the standard spaces and their subspaces. Orthogonal transformations.
   Eigenvalues and diagonalization in geometry..
   Symmetric matrices, bilinear and quadratic forms. Conics and quadrics.

3. Generalized eigenvectors.
   Complex scalars. The decomposition of a matrix into a diagonalizable and a nilpotent part. Application to systems of differential equations. Briefly: the Jordan canonical form.

4. General vector spaces.
   Main examples: function spaces.. Subspaces, basis, dimension. General inner products. Fourier series. Linear operators on inner product spaces. Adjoint operators, normal operators and their special cases.

Classroom attendance and taking verbatim notes of the classroom lectures are essential. The lectures will contain material that will not be found in the text.

Work to be done and method of evaluation:

(1) About eight (8) homework assignments. Late assignments are accepted; however, they will be graded only at the end of the course, for the purposes of calculating the final grade. *There will be no formula* stated for how late assignments will be used for the calculation of the final grade.

(2) A 2-hour midterm test. Date and time of midterm: TBA.

(3) A 3-hour final examination.

Final grade: maximum of (10% of A + 30% of M + 60% of F) and (10% of A + 90% of F), where A=assignment grade, M=midterm grade, F=final exam grade.

There will be no additional ways of upgrading the final grade.

There will be a supplemental examination, for 100% of the supplemental mark.

Exams and assignments may be written in French.

The Senate of the University has resolved that the following statement be included in this course outline: "McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offenses under the code of student conduct and disciplinary procedures (see www.mcgill.ca/integrity for more information)."