

Notes for the MATLAB Branch of the “Maple-Course” at Edinburgh, January 2008

The MATLABTM programme by The-MathWorks is a “MATrix LABoratory” (not a general Mathematical Laboratory), and has become a standard for engineers and scientist from many fields, as well as for mathematicians in the last 20 years, because it enables the easy development of new algorithms and is quite powerful in data-visualization or the solution of large linear systems.

There are many books on the market for MATLAB, just to mention a few of them: [1–5],

Let us recall what the main subject of a standard linear algebra course are: We have real or complex vector spaces of finite dimension, we discuss linear combinations, especially with respect to (finite) families of vectors which for a *unique* representation of an arbitrary element in that same vector space. Such families are known as *bases* or *coordinate systems* because there are uniquely determined real or complex numbers telling us exactly how much each of the members of such a basis is contributing to a given “vector” in that space. Only later on we will discuss concepts related to scalar products, angels between vectors, hence also the specific importance of orthonormal bases.

ORGANISATORIC REMARKS: The course will be supported by two graduate students (to be named soon), who will help especially during the Wednesday Exercise Hours in the Lab.

The homepage of my own workgroup NuHAG (which stands for Numerical Harmonic Analysis Group, at the University of Vienna) is www.nuhag.eu. The bar “DB+tools” (Databases and Tools) allows you the access a larger collection of MATLAB toolboxes designed at NuHAG, but only a little part of this will be useful for the final part of this course and perhaps for the project assignment (in the sense of better output at the cost of learning some non-standard MATLAB files).

HOW to start MATLAB in the Engineering PC-Lab (room 3211, Wednesday 11:10 - 13.00) Start > Programs > School applications > Sci.+Eng. > Eng.+Electronics > MATLAB > R2007 (preferably).

Basic instructions for the use of MATLAB (in particular about HELP and DIARY) will be given separately!

1 LESSON 1, January 8th

First some basic notations concerning MATLAB, like defining matrices (hence vectors), doing matrix-vector multiplication, random matrices

Getting entries into matrices, comparing columns, Gauss-elimination at one stroke using RREF, inverse matrix: INV(A); rank(A); det(A);

Showing how to plot;

2 LESSON 2, January 15th

subject to further reshuffling!

Outline: scalar products, orthogonal decomposition along a subspace, orthonormal bases, unitary matrices, biorthogonal systems, Gram Schmidt procedure

Geometric pictures and their numerical realization.

3 LESSON 3., January 22th

Recall some mathematical facts, like rank of a matrix (row-rank equals column rank, which means that any two bases for the row-space and the column space have the same dimension)

Linear mappings (those which respect linear combinations), building the matrix of a linear mapping for a given linear mapping (e.g. projection in x-y-plane) given a basis for the departing and target space of the linear mapping, matrices and composition rules for mappings. Inverse matrix and inversion of the linear mapping.

Polynomial functions, evaluating polynomials, Vandermonde matrices,

4 LESSON 4. January 29th

TEST, verification of understanding achieved in the first three weeks.

5 LESSONS 5 - 7:

Applications to signal and image processing

References

- [1] Jon H. Davis. *Methods of applied mathematics with a MATLAB overview*. Applied and Numerical Harmonic Analysis. Birkhäuser, Boston, MA, 2004.
- [2] Duane Hanselman and Bruce Littlefield. *Mastering Matlab5*. Matlab Curriculum Series, New Jersey 07458, 1996.
- [3] Desmond J. Higham and Nicholas J. Higham. *Matlab guide. 2nd ed.* SIAM, Society for Industrial and Applied Mathematics, Philadelphia, PA, 2nd ed. edition, 2005.
- [4] C. Moler. *Numerical Computing with MATLAB*. SIAM, Society for Industrial and Applied Mathematics, Philadelphia, PA, 2004.
- [5] Andy H. Register. *A Guide to MATLAB Object-Oriented Programming*. Chapman & Hall/ CRC, 2007.