Introduction. Algebra and MATLAB review

Mathematical tools, 2019

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Introduction

Instructor: Dr.techn. Ing. Jan Přikryl

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Consultations: only by previous appointment on Monday 15:30–16:30 at Konviktská bldg. or on Wednesday 14:00–15:00 at Horská bldg.

Website: `http://zolotarev.fd.cvut.cz/mni`

No lectures and labs in the weeks starting September 23 and October 28.

Course materials only in English.

Total of 30 ($+5$) points:

- 7 assignments (homeworks) . . . 21 points total
- individual semestral project . . . 14 points

Minima: 9 points from homeworks, 7 from the project, 16 total

Assignments

Assigned at the end of most of the labs:

- solved individually
- uploaded as PDF to the webserver
- solutions will be typeset, graphs will be vectors, not bitmaps, code will be documented
- a set of solutions that are identical will be graded as a single solution, and a fraction of points will be awarded to every submission in the set

Demonstrates the ability to perform basic signal processing tasks on selected signal family using DFT/FFT, wavelet transform, and to use appropriate windowing and resampling techniques. Consists of written report and corresponding MATLAB code.

The report will be typeset, graphs will be vectors, code will be documented.

Project topic has to be approved by the instructor by November 30.

Evaluation criteria:

- 40 % formal quality of the written report (structuring, citations, etc.)
- 60 % clarity of the presentation

Course Content

1. Polynomials and Taylor Polynomials, Factoring a Polynomial

2. Vector Spaces, Signals, and Images

3. Series and Fourier Series

4. Discrete Fourier Transform

5. Stationary and Non-stationary Signals

6. Windowing and Localization

7. Short Time Fourier Transform

8. Wavelets

9. Analysis of a Non-stationary Signal

Knowledge of the following is expected. Use the first lecture and lab to refresh your knowledge.

- Linear Algebra, Matrix and Vector Operations
- Derivatives and Integration of Functions
- Solution of Differential Equation
- Series, Convergence, Taylor Series
- Good command of MATLAB

In the second lab, an obligatory review test takes place. I need you to know what shape you are in before we approach some trickier parts of the syllabus.

- Consists of theoretical (algebra, calculus) part and practical (MATLAB) part
- No minimum, only indicatory
- Does not contribute to the grading

Further Reading

- Kenneth B. Howell: *Principles of Fourier Analysis*, Chapman & Hall/CRC, 2001, ISBN 0-8493-8275-0

- Steven W. Smith: *The Scientist and Engineer's Guide to Digital Signal Processing*, California Technical Publishing, ISBN 0-9660176-7-6

- S. Allen Broughton and Kurt Bryan: *Discrete Fourier Analysis and Wavelets*, John Wiley & Sons, Inc. Publication, 2009, ISBN 978-0-470-29466-6

- MATLAB ®*The Language of Technical Computing*, Getting Started with MATLAB, MathWorks, Inc.

- MATLAB ®*Signal Processing Toolbox User's Guide*, MathWorks, Inc.

Topics to Review

Algebra:

- vectors and matrices, vector and matrix calculus
- linear independence, basis, normality, orthonormality
- linear spaces and subspaces

Calculus:

- derivatives and antiderivatives of x^n, e^{ax}, $\sin x$, $\cos x$
- calculus of composite functions (per-partes, l'Hospital rule, etc.)
- calculus of complex numbers
- solving ODE of up to second order

- working with (normal and cell) vectors and matrices
- basic matrix and vector generating functions
- boolean indexing, `find()`, `mean()`, ...
- plotting, subplots, annotating and saving figures
- reading and saving `.mat`, CSV and sound files
- M-files, and
  - loops (i.e. `for`, `while`)
  - conditionals (i.e. `if`, `else`)