Advanced Mathematics in Geodesy and Surveying - BMEEOAFDT71

I. Subject Specification

1. Basic Data

1.1 Title

ADVANCED MATHEMATICS IN GEODESY AND SURVEYING

1.2 Code

BMEEOAFDT71

1.3 Type

Module with associated contact hours

1.4 Contact hours

Type	Hours/week / (days)
Lecture	2

1.5 Evaluation

Exam

1.6 Credits

3

1.7 Coordinator

name	Dr. Gyula Károly Tóth
academic rank	Associate professor
email	toth.gyula@emk.bme.hu

1.8 Department

Department of Geodesy and Surveying

1.9 Website

https://epito.bme.hu/BMEEOAFDT71
https://edu.epito.bme.hu/course/view.php?id=4918

1.10 Language of instruction

english

1.11 Curriculum requirements

Compulsory in the Land Surveying and Geoinformatics (MSc) programme

1.12 Prerequisites

1.13 Effective date

1 September 2022

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2. Objectives and learning outcomes

2.1 Objectives

Goal of the subject is that the student be familiar with advanced applied mathematical methods that are widely used in geodesy and civil engineering and their fields of application. Knowledge acquired during this course should enable the student to understand and apply main mathematical methods that can be found in research papers in his field. Detailed practical examples help the application of the various methods studied.

2.2 Learning outcomes

Upon successful completion of this subject, the student:

A. Knowledge

1. knows basics of data processing with continuous and discrete wavelets,
2. familiar with basics, main types and applications of Kalman filtering,
3. knows most important principles of digital filter design,
4. knowledgeable about most important pros and cons of various PSD estimation methods,
5. understands the merits of most frequent value procedures in comparison with traditional statistics,
6. can make distinction between traditional and bayesian statistical approaches.

B. Skills

1. can use robust and resistant data processing methodologies,
2. can routinely apply spectral estimation methods for data processing.

C. Attitudes

1. open to adopt recent mathematical methods in his field of research,
2. has a critical attitude towards the limits of widely used mathematical procedures,
3. quick to expand his knowledge

D. Autonomy and Responsibility

1. makes independent research decisions on the used mathematical procedures

2.3 Methods

lectures, interactive Jupyter notebooks

2.4 Course outline

Week	Topics of lectures and/or exercise classes
1.	Singular value decomposition (SVD), principal component analysis (PCA)
2.	Kalman filtering, derivation of the filter
3.	Extended Kalman filtering (EKF), unscented Kalman filtering (UKF)
4.	RANSAC estimation, ellipse, sphere, cylinder fitting
5.	Fourier transform, FFT, Fourier spectra of wheel accelerometry
6.	Continuous wavelet transform (CWT), wavelet filtering
7.	Discrete orthogonal wavelet transform (DWT)
8.	Digital filters, z-transform
9.	Parametric and nonparametric PSD estimation
10.	Basics of Bayesian statistics and its applications
11.	Most frequent value procedures (MFV) and its applications in geosciences
12.	Lattices, LLL lattice reduction, integer least squares
13.	Shifted linear interpolation / Introduction to Artificial Neural Networks
14.	Discussion of a topic proposed by students

The above programme is tentative and subject to changes due to calendar variations and other reasons specific to the actual semester. Consult the effective detailed course schedule of the course on the subject website.

2.5 Study materials

- Awange, J.L., Paláncz, B., Lewis, R.H., Völgyesi, L.: Mathematical Geosciences. Hybrid Symbolic-Numeric Methods. Springer, 2018.
- Csernyák L., Hajagos B., Hursán G., Steiner F., Szűcs P., Turai E., 1997. Optimum methods in statistics. Akadémiai Kiadó, Budapest.
- Koch, K.R.: Introduction to Bayesian Statistics. 2nd Ed. Springer, 2007.
- Najim, M.: Modeling, Estimation and Optimal Filtration in Signal Processing. Wiley & Sons, 2008.
- O'Hagan, A.: The Bayesian Approach to Statistics. in: Handbook of Probability: Theory and Applications, SAGE Publications Inc., 2008.
- Olea, R.A.: Geostatistics for Engineers and Scientists. Kluwer Academic Publishers, 1999.
- Steiner F.: The Most frequent value: introduction to a modern conception of statistics. Academic Press Budapest, 1991.
- Strang, G., Borre, K.: Linear Algebra, Geodesy, and GPS. Wellesley Press, Cambridge, 1997.
- Sundararajan, D.: Discrete Wavelet Transform: A Signal Processing Approach. Wiley & Sons, 2015.
- Torrence, C., Compo, G.: A Practical Guide to Wavelet Analysis. Bulletin of the American Meteorological Society, Vol. 79, No. 1, pp. 61–78.
- Vanicek, P., Krakiwsky, E.J. : Geodesy: The Concepts. Part III. Methodology. North-Holland, 1986.

2.6 Other information

2.7 Consultation

This Subject Datasheet is valid for:

2025/2026 semester I

II. Subject requirements

Assessment and evaluation of the learning outcomes

3.1 General rules

3.2 Assessment methods

Evaluation form	Abbreviation	Assessed learning outcomes
Exam	E	A.1-A.6; B.1-B.2; C.1-C.3; D.1

The dates of deadlines of assignments/homework can be found in the detailed course schedule on the subject's website.

3.3 Evaluation system

Abbreviation	Score
E	100%
Sum	**100%**

3.4 Requirements and validity of signature

3.5 Grading system

Grade	Points (P)
excellent (5)	80<=P
good (4)	70<=P<80%
satisfactory (3)	60<=P<70%
passed (2)	50<=P<60%
failed (1)	P<50%

3.6 Retake and repeat

3.7 Estimated workload

Activity	Hours/semester
contact hours	14×2=28
preparation for the exam	62
Sum	**90**

3.8 Effective date

1 September 2022

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2025/2026 semester I