

BASIC DATA PROCESSING METHODS FOR OILFIELD GEOPHYSICS AND PETROPHYSICS

Petroleum Geoengineering MSc course

2021/22 1st Semester

COURSE COMMUNICATION FOLDER

University of Miskolc Faculty of Earth Science and Engineering Institute of Geophysics and Geoinformatics

Course datasheet

Course Title: Basic data processing methods for oilfield Credit geophysics and petrophysics (Petroleum Geoengineering MSc, Optional courses II.)

Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: lec.1 + sem.1

Neptun code: MFGFT730013

Type of Assessment (exam. / pr. mark. / other): pr. mark

Signature requirements: attendance on minimum 51 percent of the seminars and pass grade on two midterm exams.

Practical mark: the arithmetical mean of the result of two midterm exams if both results were at least satisfactory.

Grading scale:

Grade
5 (excellent)
4 (good)
3 (satisfactory)
2 (pass)
1 (failed)

Position in Curriculum (which semester): third

Pre-requisites (*if any*): no

Course Description:

The course gives mathematical fundamentals of spectral data processing methods and its usage in fields of oilfield geophysics and petrophysics.

Competencies to evolve:

Knowledge: T1, T5, T7, T10, T11, T12.

Ability: K2, K3, K7, K10.

Attitude: A1, A9.

Autonomy and responsibility: F2.

The short curriculum of the subject:

Basis of information theory. Signal theory. Discretization. Errors of discretization. A/D conversion. A/D converters. Spectral transformation (Fourier-transform, Discrete Fourier Transform, Fast Fourier Transform, Z-transform). Spectrum calculation using Z-transformation. Convolution. Discrete convolution. Correlation functions. Discrete correlation functions. Basis of deterministic and stochastic filtering. Image processing. Education method: Practices using software and ppt presentation to learn processing

methods.

The compulsory, or recommended literature (textbook, book) resources:

- Meskó A, 1984: Digital filtering. Academic Press Inc, Budapest.
- Menke, W, 1984: Geophysical Data Analysis: Discrete Inverse Theory. Academic Press Inc.
- Candy, J V, 1986: Signal Processing, McGraw-Hill Book Co.

- Bath, M, 1974: Spectral Analysis in Geophysics, Elsevier Scientific Publishing Co.
- Bracewell, R N, 1978: The Fourier Transform and its Applications, McGraw-Hill Book Co.

Course Managed by (*name, position, scientific degree*): **Endre Kázmér Nádasi, assistant lecturer**

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*): -

Syllabus of the semester

Week	Lecture and seminar	
September 7.	Starting test. Basis of information theory. Signal theory.	
September 14.	Discretization. Errors of discretization.	
September 21.	A/D conversion. A/D converters.	
September 28.	Fourier-transform. Discrete Fourier Transform (DFT).	
October 5.	Fast Fourier Transform. Z-transform. Spectrum calculation using Z-transformation.	
October 12.	Convolution. Discrete convolution.	
October 19.	1st written midterm exam.	
October 26.	Correlation functions (auto- and cross-correlation function).	
November 2. No education	No education.	
November 9.	Discrete correlation functions (discrete auto- and cross-correlation function).	
November 16.	Basis of deterministic and stochastic filtering.	
November 23.	Image processing.	
November 30.	2nd written midterm exam.	
December 7.	Semester closing.	

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Basic data processing methods for oilfield geophysics and petrophysics.1st midterm practical exam, A(Solution time: 50 minutes)Petroleum Geoengineering MSc

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- 1. Draw up the error vector of discretization in a complex plan when there is an angle of 60 degrees between the error vector and horizontal axis (10 points).
- 2. Give the sampling error in percent when sampling number is $5 \cdot 10^3$ (10 points).
- 3. Give the conversion error (amplitude resolution error) of 10 bits A / D converter in percent (10 points).
- 4. Derive dimension right Inverz DFT formula (8 points) and index right Inverz DFT formula (4 points) from analytic Fourier-transform.
- 5. Calculate and give the type of following filter (10 points).

$$\{w_n\} = \left(-1, 2, -1, 1\right), \Delta t = 0.5 \text{ sec}.$$

- 6. Calculate the **6** bits digital code of **651** mV in **0** mV and **1024** mV signal interval (24 points).
- 7. Calculate the complex spectrum F(f) of the following discrete data series using Z-transformation and give real spectra Re(f), Im(f), A(f) and $\Phi(f)$ of the complex spectrum (24 points).

$$\begin{bmatrix} 1, -1, 2, 1, -2 \end{bmatrix}$$
, $\Delta t = 2 \sec, f = 0, 125$ Hz.

Result: 80.5-100.0 points: A1 level (5), 70.5-80.0 points: A2 level (4.5), 60.5-70.0 points: B level (4), 50.5-60.0 points: C level (3.5), 40.5-50.0 points: D level (3), 30.5-40.0 points: E1 level (2.5), 20.5-30.0 points: E2 level (2), 0.0-20.0 points: F level (1).

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2nd midterm practical exam (Solution time: 75 minutes)

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Given the following time series: 1.

$$\{x_n\} = (\stackrel{\downarrow}{1}, -1, 1, 2, -2), \qquad \{y_n\} = (\stackrel{\downarrow}{1}, -2, 2, 2, -1).$$

Calculate the discrete corrected cross-correlation function 1.a., $\{R_{xy}(k)\}=(R_{-3},R_{-2},R_{-1},R_0,R_1,R_2,R_3)$, and illustrate the result in figure using Dirac pulse sequence (24 points).

 $\Delta t = 0.5 \ sec$.

- Calculate the discrete corrected autocorrelation function: 1.b., $\{R_{xx}(k)\} = (R_{-3}, R_{-2}, R_{-1}, R_0, R_1, R_2, R_3)$, and illustrate the result in figure using Dirac pulse sequence (16 points).
- 2. Derive the dimension right discrete cross-correlation formula (6 points) and index right discrete crosscorrelation formula (4 points) from analytic cross-correlation.
- Given the following discrete time series: $\Delta t = 2 \sec$, $\{x_n\} = (2,1,-2,1,0,2,-1,2), \qquad \{w_n\} = (1,-1,3,-2)$ Determine the values of discrete convolution $\{x_n\}^* \{w_n\}$ and the draw the functions w_n , x_n and y_n in 3.

figure using Dirac pulse sequence (30 points).

Calculate and give the type of following filter (10 points). 4.

$$\{w_n\} = \left(2, -2, 4, -1, 1\right), \qquad \Delta t = 0.5 \text{ sec}.$$

7. Give and draw up the A(f) spectrum of transmission characteristics (W(f)) of an ideal bandpass filter (10 points).

Result:	80.5-100.0 points:	A1 level (5),
	70.5-80.0 points:	A2 level (4.5),
	60.5-70.0 points:	B level (4),
	50.5-60.0 points:	C level (3.5),
	40.5-50.0 points:	D level (3),
	30.5-40.0 points:	E1 level (2.5),
	20.5-30.0 points:	E2 level (2),
	0.0-20.0 points:	F level (1).