



# BASIC DATA PROCESSING METHODS FOR OILFIELD GEOPHYSICS AND PETROPHYSICS

Petroleum Geoengineering MSc course

2020/21 1st Semester

COURSE COMMUNICATION FOLDER

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

## Course datasheet

<b>Course Title: Basic data processing methods for oilfield geophysics and petrophysics (Petroleum Geoengineering MSc, Optional courses II.)</b>	<b>Credits: 4</b>												
<b>Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: lec.1 + sem.1</b>													
<b>Neptun code: MFGFT730013</b>													
<p><b>Type of Assessment</b> (exam. / pr. mark. / other): <b>pr. mark</b>  <i>Signature requirements:</i> attendance on minimum 51 percent of the seminars and pass grade on two midterm exams.  <i>Practical mark:</i> the arithmetical mean of the result of two midterm exams if both results were at least satisfactory.</p> <p><b>Grading scale:</b></p> <table border="0"> <tr> <td>% value</td> <td>Grade</td> </tr> <tr> <td>86 –100%</td> <td>5 (excellent)</td> </tr> <tr> <td>71 – 85%</td> <td>4 (good)</td> </tr> <tr> <td>56 – 70%</td> <td>3 (satisfactory)</td> </tr> <tr> <td>41 – 55%</td> <td>2 (pass)</td> </tr> <tr> <td>0 – 40%</td> <td>1 (failed)</td> </tr> </table>		% value	Grade	86 –100%	5 (excellent)	71 – 85%	4 (good)	56 – 70%	3 (satisfactory)	41 – 55%	2 (pass)	0 – 40%	1 (failed)
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56 – 70%	3 (satisfactory)												
41 – 55%	2 (pass)												
0 – 40%	1 (failed)												
<b>Position in Curriculum (which semester): third</b>													
<b>Pre-requisites (if any): no</b>													
<p><b>Course Description:</b>  The course gives mathematical fundamentals of spectral data processing methods and its usage in fields of oilfield geophysics and petrophysics.</p> <p><b>Competencies to evolve:</b>  <b>Knowledge:</b> T1, T5, T7, T10, T11, T12.  <b>Ability:</b> K2, K3, K7, K10.  <b>Attitude:</b> A1, A9.  <b>Autonomy and responsibility:</b> F2.</p>													
<p><b>The short curriculum of the subject:</b>  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.</p> <p><b>Education method:</b> Practices using software and ppt presentation to learn processing methods.</p>													
<b>The compulsory, or recommended literature (textbook, book) resources:</b>													
<ul style="list-style-type: none"> <li>• Meskó A, 1984: Digital filtering. Academic Press Inc, Budapest.</li> <li>• Menke, W, 1984: Geophysical Data Analysis: Discrete Inverse Theory. Academic Press Inc.</li> <li>• Candy, J V, 1986: Signal Processing, McGraw-Hill Book Co.</li> </ul>													

- 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*):

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## **Syllabus of the semester**

<b>Week</b>	<b>Lecture and seminar</b>
08/09/2019	Starting test. Basis of information theory. Signal theory.
10/09/2019	Discretization. Errors of discretization.
22/09/2019	A/D conversion. A/D converters.
29/09/2019	Fourier-transform. Discrete Fourier Transform (DFT).
06/10/2019	Fast Fourier Transform. Z-transform. Spectrum calculation using Z-transformation.
13/10/2019	1st written midterm exam.
20/10/2019	Professional Information Day (no education)
27/10/2019	Convolution. Discrete convolution.
03/11/2019	Correlation functions (auto- and cross-correlation function).
10/11/2019	Discrete correlation functions (discrete auto- and cross-correlation function).
17/11/2019	Basis of deterministic and stochastic filtering.
24/11/2019	Image processing.
01/12/2019	2nd written midterm exam.
08/12/2019	Semester closing.

**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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*Name with Neptun code*

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).

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

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).

$$\left[ \overset{\downarrow}{1}, -1, 2, 1, -2 \right], \Delta t = 2 \text{ sec}, f = 0,125 \text{ Hz}.$$

<b>Result:</b>	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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Name with Neptun code

1. Given the following time series:  $\Delta t = 0.5 \text{ sec}$ ,  
 $\{x_n\} = (\overset{\downarrow}{1}, -1, 1, 2, -2)$ ,  $\{y_n\} = (\overset{\downarrow}{1}, -2, 2, 2, -1)$ .
  - 1.a., Calculate the discrete corrected cross-correlation function  $\{R_{xy}(k)\} = (R_{-3}, R_{-2}, R_{-1}, R_0, R_1, R_2, R_3)$ , and illustrate the result in figure using Dirac pulse sequence (24 points).
  - 1.b., Calculate the discrete corrected autocorrelation function:  $\{R_{xx}(k)\} = (R_{-3}, R_{-2}, R_{-1}, R_0, R_1, R_2, R_3)$ , 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 cross-correlation formula (4 points) from analytic cross-correlation.
3. Given the following discrete time series:  $\Delta t = 2 \text{ sec}$ ,  
 $\{x_n\} = (\overset{\downarrow}{2}, 1, -2, 1, 0, 2, -1, 2)$ ,  $\{w_n\} = (\overset{\downarrow}{1}, -1, 3, -2)$   
 Determine the values of discrete convolution  $\{x_n\} * \{w_n\}$  and draw the functions  $w_n$ ,  $x_n$  and  $y_n$  in figure using Dirac pulse sequence (30 points).
4. Calculate and give the type of following filter (10 points).  
 $\{w_n\} = (\overset{\downarrow}{2}, -2, 4, -1, 1)$ ,  $\Delta t = 0.5 \text{ sec}$ .
7. Give and draw up the  $A(f)$  spectrum of transmission characteristics ( $W(f)$ ) of an ideal bandpass filter (10 points).

<b>Result:</b>	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).