ENGINEERING AND ENVIRONMENTAL GEOPHYSICS

MS in Earth Science Engineering, Geophysical Engineering specialization

Second semester 2022/2023

COURSE COMMUNICATION DOCUMENT

University of Miskolc
Faculty of Earth Science and Engineering
Institute of Exploration Geosciences

Course datasheet

Course title: Engineering and environmental geophysics **Responsible professors**: Norbert Péter Szabó Prof. Dr., Ph.D., dr. habil., D.Sc., full professor	**Code**: MFGFT720013 **Responsible Institute/Department:** Institute of Exploration Geosciences / Department of Geophysics
Semester: second	**Pre-requisites**: MFGFT6002D, MFGFT6003D
Number of Contact Hours per Week: 2 lec. + 1 lab.	**Type of Assessment** (exam. / pr. mark / other): pr. mark
Credits: 4	**Type of Program**: full time **Program and Specializations**: MS in Earth Science Engineering, Geophysical Engineering

Study goals:

Analysis of geotechnical, engineering geological, hydrogeological and environmental applications of near-surface geophysical methods, as well as a description of specific methods and their development trends.

Competencies to be developed:

Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9
Ability: K1, K2, K3, K12, K13
Attitude: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Course content:

Principles of surface geophysical methods. Gravity, magnetic, DC geoelectric, electromagnetic surveys. Ground penetrating radar (GPR), seismic refraction and surface wave's methods. Surface Nuclear Magnetic Resonance (sNMR) method. Description of the engineering geophysical penetration sounding methods and applications. Characterization of shallow unconsolidated sediments. Special borehole geophysical measurements: borehole radar, NMR. Investigating the relationship between the petrophysical, lithological and geotechnical characteristics and measured physical parameters. Single and joint interpretation of geophysical data (single and joint inversion, tomography) based on different physical bases for 1D, 1.5D, 2D and 3D models. Application of shallow geophysical methods for environmental and engineering tasks and water prospecting. Special tasks in void detection, hydrogeophysics, archaeological geophysics. Forensic and military applications. Presentation of geophysical instruments in laboratory. Instruments applied in the field practice.

Type of assessment:

Attendance at lectures is regulated by the university code of education and examination. Two writing tests (the weight of each grade item is 50 %). One assignment during the semester is the requirement of signature.

Grading scale: >86 %: excellent, 71-85 %: good, 61-70 %: medium, 46-60 %: satisfactory, <45 %: unsatisfactory.

Compulsory and recommended literature resources:

- Sharma P. V., 1997. Environmental and engineering geophysics. Cambridge University Press.
- Everett M. E. , 2013. Near-surface applied geophysics. Cambridge University Press.
- Milsom J., 2003. Field Geophysics. 3rd edition. Wiley.
- Kirsch R. (editor), 2009. Groundwater Geophysics – A Tool for Hydrogeology. Springer.
- Butler, D.K. (szerk.), 2005: Near-Surface Geophysics (in series: Investigations in Geophysics, No. 13.) SEG, Tulsa.
- Szabó N. P., 2014. Environmental and engineering geophysics. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html

Course schedule

Date	Lecture
28-Feb	Classification of near-surface applied geophysical methods. Basic principles of microgravity surveying methods, correction of measurements. Calculation of derivatives. Engineering and environmental applications.
7-Mar	Basic principles of magnetic methods, correction of measurements. Magnetic gradiometry. Pole reduction and analytic continuation techniques. Engineering and environmental applications.
14-Mar	DC geoelectric measurement methods. Inversion and interpretation of pseudo-resistivity profiles, maps. Engineering, environmental, archaeological and geophysical applications.
21-Mar	Time- (TDIP) and frequency domain (FDIP) induced polarization measurements. Geological causes of polarization types. The time constant spectrum. The delineation of contaminated zones.
28-Mar	Frequency-domain EM surveying methods. The induction method. Shallow applications of frequency sounding.
4-Apr	Writing the first test.
11-Apr	Holiday declared by rector
18-Apr	Miners' Sports Day
25-Apr	Time-domain (transient) EM surveying methods and their shallow applications. Detection of highly conductive structures. The physical background of surface nuclear magnetic resonance sounding. Determination of the depth distribution of the water content.
2-May	Near-surface application of the seismic method. Refraction method, its theory and possibilities of use.

9-May	Near-surface application of the seismic method. Surface-wave seismic method.
16-May	Theory of engineering geophysical sounding methods. Investigation of the relationship between the petrophysical (water, air saturation, clay content, matrix fraction) and geotechnical (dry density) characteristics and measured physical parameters. Opportunities for inversion evaluation.
23-May	Writing the second test.
30-May	Repeating the writing tests. Submission of individual assignment.

Date	**Seminar**
2-Mar	Inversion and interpretation of microgravity data. Application examples.
9-Mar	Inversion and interpretation of magnetic data. Application examples.
16-Mar	Inversion and interpretation of DC geoelectric data. Application examples.
23-Mar	Inversion and interpretation of TDIP data. Application examples.
30-Mar	Interpretation of FDEM and TDEM data. Application examples.
6-Apr	Holiday declared by rector
13-Apr	Interpretation of TDEM data. Application examples.
20-Apr	Interpretation of sNMR data. Application examples.
27-Apr	Presentation of the measuring instruments (laboratory practice).
4-May	Processing and interpretation of refraction seismic data. Application examples.

11-May	Inversion of direct push logs. Applications.
18-May	Presentation of the measuring instruments (field practice). Submission of individual assignment.
25-May	Consultation questions.
1-Jun	No teaching.

Sample of writing test

1. What type of data reduction techniques are applied to microgravity data?
2. What type of geophysical methods can be used to sinkhole detection?
3. What type of well logs are used in the evaluation of aquifers? What petrophysical parameters are determined?
4. Determination of low-velocity layer parameters (V_0, V_1, h_0) with refraction survey. Steps of plus-minus processing method.
5. Please detail P and S wave down-hole and cross-hole measurements. Give the calculation formulas for basic elastic parameters.

Solution

The answers can be found in the course material “Environmental and engineering geophysics” (and the recommended literature) uploaded to the site of the Department of Geophysics: http://www.uni-miskolc.hu/~geofiz/education.html