ENGINEERING AND ENVIRONMENTAL GEOPHYSICS

MS in Earth Science Engineering, Geophysical Engineering specialization

Second semester 2024/2025

COURSE COMMUNICATION DOCUMENT

University of Miskolc
Faculty of Earth and Environmental Sciences 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: Knows and applies scientific and technical theory and practice related to the profession of environmental engineering. Has a comprehensive knowledge of measurement technology and measurement theory related to the field of environmental engineering. Knows and applies environmental and remediation procedures (operations, equipment, devices), environmental remediation methods. Knows the operation of environmental protection facilities (especially water and wastewater treatment plants, hazardous and communal landfills, waste incinerators), their structures and the possibilities of their development. Knows and applies the rules of environmental impact assessment and preparation of environmental technical documentation. Knows the organizational and motivational tools and methods related to management, as well as the legislation necessary for practicing the profession. Knows and applies the methodology and tools of environmental informatics and modeling in a complex way. Knows the basics, boundaries, and requirements of the fields of work, as well as fire protection, safety technology, information technology, law, economics and management related to environmental engineering. Knows the promotion and opinion-forming methods related to environmental engineering.

Ability: Can apply the acquired general and specific mathematical, natural, and social science principles, rules, connections, and procedures in solving problems arising in the field of environmental protection. Able to conduct publications and negotiations in his/her field in his/her mother tongue and at least one foreign language. Able to perform environmental management tasks. Able to design, implement and operate environment-focused management systems. Able to perform energy efficiency analyzes, surveys, audits, identify measures and support their implementation.

Attitude: Open and receptive to the knowledge and acceptance of professional, technological development and innovation in the field of environmental protection, and its authentic mediation. Assumes the professional and moral values related to the field of environmental protection. Seeks to plan and carry out tasks independently or in a working group at a professional level. Strives to carry out the required work in a complex approach based on a systems-based and process-oriented way of thinking. Strives to improve the knowledge of both him/herself and subordinated employees through continuous training. Shares experiences with co-workers, thus helping their development.

Autonomy and responsibility: Can solve environmental engineering tasks independently, takes decisions carefully, in consultation with the representatives of other (mainly legal, economic, energy) fields, independently, takes responsibility for the decisions. In making decisions, considers the basic requirements of occupational health and safety, technical, economic, and legal regulations, and engineering ethics. Takes the initiative in solving environmental problems, identifies the shortcomings of the applied technologies, the risks of the processes and initiates the measures to reduce them. Shares the acquired knowledge and experience with formal, non-formal and informal information transfer with practitioners in their field. Evaluates the work of subordinated employees, promotes their professional development by sharing critical remarks, educates employees and subordinates on responsible and moral professional practice.

Course content
Principles of surface geophysical methods. Gravity, magnetic, DC geoelectric, electromagnetic surveys. Ground penetrating radar (GPR), seismic refraction 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 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 the laboratory. Instruments applied in 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. https://exploration.uni-miskolc.hu/files/26295/El%C5%91ad%C3%A1s-EEG.pdf

Course schedule

Date	Lecture
11-Feb	Classification of near-surface applied geophysical methods. Basic principles of microgravity surveying methods, correction of measurements. Calculation of derivatives. Engineering and environmental applications.
18-Feb	Basic principles of magnetic methods, correction of measurements. Magnetic gradiometry. Pole reduction and analytic continuation techniques. Engineering and environmental applications.
25-Feb	DC geoelectric measurement methods. Inversion and interpretation of pseudo-resistivity profiles, maps. Engineering, environmental, archaeological and geophysical applications.
3-Mar	Time- (TDIP) and frequency domain (FDIP) induced polarization measurements. Geological causes of polarization types. The time constant spectrum. The delineation of contaminated zones.

11-Mar	Frequency-domain EM surveying methods. The induction method. Shallow applications of frequency sounding.
18-Mar	Writing the first test.
25-Mar	Time-domain (transient) EM surveying methods and their shallow applications. Detection of highly conductive structures.
1-Apr	The physical background of surface nuclear magnetic resonance sounding.
8-Apr	Determination of the depth distribution of the water content. Near-surface application of the seismic method. Refraction method, its theory and possibilities of use.
15-Apr	Near-surface application of the seismic method.
22-Apr	Holiday declared by Rector.
29-Apr	Holiday declared by Rector.
6-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.
13-May	Writing the second test.
20-May	Repeating the writing tests. Submission of individual assignment.

Date	**Seminar**
13-Feb	Inversion and interpretation of microgravity data. Application examples.
20-Feb	Inversion and interpretation of magnetic data. Application examples.
27-Feb	Inversion and interpretation of DC geoelectric data. Application examples.

6-Mar	Inversion and interpretation of TDIP data. Application examples.
13-Mar	Interpretation of FDEM and TDEM data. Application examples.
20-Mar	Interpretation of TDEM data. Application examples.
27-Mar	Interpretation of seismic reflection data. Processing and interpretation of refraction seismic data. Application examples.
3-Apr	Interpretation of sNMR data. Application examples.
10-Apr	Shallow well logging measurements and interpretation.
17-Apr	Hydrogeophysical methods. Presentation of the measuring instruments (laboratory practice).
24-Apr	Holiday declared by Rector.
1-May	Labour Day.
8-May	Inversion of direct push logs. Applications.
15-May	Presentation of the measuring instruments (field practice). Submission of individual assignment.
22-May	Consultation questions.

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 for 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: https://exploration.uni-miskolc.hu/files/26295/El%C5%91ad%C3%A1s-EEG.pdf