ENVIRONMENTAL AND ENGINEERING GEOPHYSICS

Environmental Engineering MSc

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: Environmental and Engineering Geophysics	**Credits: 5**
Type of course: compulsory	Program: Environmental Engineering MSc Neptun code: MFGFT720018
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **2 lec. + 2 lab.**	
Type of Assessment (exam. / pr. mark. / other): **exam (oral)** Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively, and two individual assignments (one powerpoint presentation and one report on field practice) during the semester are the requirement of signature. Grading scale: > 86 %: excellent, 71-85 %: good, 61-70 %: medium, 46-60 %: satisfactory, <45 %: unsatisfactory.	
Position in Curriculum (which semester): **second**	
Pre-requisites *(if any)*: -	
Course Description:	

Study goals

Understanding the basics of shallow geophysical surveying methods, through which the geometric and geophysical parameters of the subsurface environment can be determined, primarily for environmental research purposes. Overview of special geophysical methods and their developmental trends.

Course content

Principles of near-surface geophysical methods. Microgravity and magnetic surveys. DC geoelectric, multi-electrode, induced polarization, electromagnetic techniques. Ground penetrating radar, seismic refraction, and surface NMR methods. Principles of engineering geophysical sounding (direct push) methods. The application of direct push methods. Investigation of the geophysical parameters and the lithological/geotechnical properties of soils/rocks. Interpretation of geophysical data by deterministic methods. Statistical and inversion-based interpretation methods. 1D, 2D and 3D modeling of shallow geological structures. Geophysical inversion methods, numerical aspects. Engineering and environmental applications: sinkhole detection, investigation of voids and cavities. Seawater intrusion, contamination assessment, archeo-geophysics, forensic studies, and unexploded ordnance detection. Geophysical and geotechnical characterization of soils, road constructions etc.

Education method

Lectures with projected PowerPoint presentation, laboratory, and field measurements.

Competencies to evolve

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.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- Sharma P. V., 1997. Environmental and engineering geophysics. Cambridge University Press.
- Everett M. E., 2013. Near-surface applied geophysics. Cambridge University Press.
- Kirsch R. (editor), 2009. Groundwater Geophysics – A Tool for Hydrogeology. Springer.
- Butler, D. K. (ed.), 2005: Near-Surface Geophysics (in series: Investigations in Geophysics, No. 13.) SEG, Tulsa.
- Scientific papers selected from geophysical journals, e.g., First Break, Near Surface Geophysics, Geophysics, Journal of Applied Geophysics etc.
- Szabó N. P., 2014. Environmental and engineering geophysics. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html

Responsible Instructor (*name, position, scientific degree):* **Norbert Péter Szabó Prof. Dr., full professor, Ph.D., dr. habil, D.Sc.**
Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

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. Environmental and engineering applications.
18-Feb	Basic principles of magnetic methods, correction of measurements. Magnetic gradiometry. Environmental and engineering applications.
25-Feb	DC geoelectric measurement methods. Interpretation of resistivity profiles, maps. Environmental, archaeological, and geophysical applications.
3-Mar	Time- and frequency domain 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.
1-Apr	Near-surface application of the seismic method. Refraction method, its theory, and possibilities of use. Environmental and engineering applications of the seismic method.
8-Apr	The physical background of surface nuclear magnetic resonance soundings. Determination of the depth distribution of the water content. Well-logging in shallow wells. Well logging methods used for the determination of lithology, porosity, and water saturation. Groundwater well logging applications. Borehole radar measurements.
15-Apr	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.
22-Apr	Holiday declared by Rector.

29-Apr	Holiday declared by Rector.
6-May	Inversion of direct-push logs. Statistical evaluation of the engineering geophysical sounding logs.
13-May	Writing the second test.
20-May	Repeating the writing tests.

Date	**Seminar**
13-Feb	Mathematical and physical basics of microgravity method, correction of measurements. Inversion of gravity data.
20-Feb	Mathematical and physical basics of magnetic method, correction of measurements. Inversion of magnetic data.
27-Feb	Mathematical and physical basics of DC geoelectric methods. Inversion of resistivity data.
6-Mar	Mathematical and physical basics of induced polarization methods. The Tau-transform.
13-Mar	Mathematical and physical basics of FDEM methods.
20-Mar	Mathematical and physical basics of TDEM methods.
27-Mar	Mathematical and physical background of seismic methods.
3-Apr	Interpretation of sNMR data. Application examples.
10-Apr	Presentation of the measuring instruments (laboratory practice).
17-Apr	The mathematics of well logging and engineering geophysical sounding methods. The forward problem. Giving the assignment (one powerpoint presentation) to the students. Selection of topics.
24-Apr	Holiday declared by Rector.

1-May	Labour Day.
8-May	Direct push log interpretation. The estimation of petrophysical (soil) parameters using inversion techniques.
15-May	Simulated conference. Students deliver powerpoint presentations on the assigned topics. Evaluation of presentations. Summary of course material and improvement of writing tests.
22-May	Consultation questions.

Sample of exam questions

1. Principles of the gravity method and the main corrections made to microgravity data.
2. Application of EM methods in near-surface investigations.
3. Principles of engineering geophysical sounding methods and their environmental applications.
4. The workflow of geophysical inversion. Petrophysical modeling of shallow geological structures. Inversion of well logs.
5. Geophysical and geotechnical characterization of soils. Inversion of direct push data.
6. Engineering and environmental applications: sinkhole detection, investigation of voids and cavities, seawater intrusion, contamination assessment, archeo-geophysical issues, unexploded ordnance detection.