UNIVERSITY OF MISKOLC

FACULTY OF
EARTH AND ENVIRONMENTAL
SCIENCE AND ENGINEERING

GROUNDWATER PROSPECTING AND MANAGEMENT

Hydrogeology Engineer MSc

2023/24 Semester II.

COURSE COMMUNICATION FOLDER

University of Miskolc
Faculty of Earth and Environmental Science and Engineering
Institute of Water Resources and Environmental Management

Tartalomjegyzék

1. Tantárgyleírás, tárgyjegyző, óraszám, kreditérték

Course Title: Groundwater prospecting, water resources management **Instructor:** Andrea Tóth Dr. Kolencsikné, assistant lecturer	**Code:** MFKHT720021 **Responsible department/institute:** Institute of Water Resources and Environmental Management
	Type of course: Compulsory
Position in curriculum (which semester): 2	**Pre-requisites (if any):** -
No. of contact hours per week (lecture + seminar): 2+1	**Type of Assessment (examination/ practical mark / other):** exam
Credits: 4	**Course:** full time

Course Description:
The course gives an overview of the different GW occurrences, and of properties of aquifers. The students gain a basic knowledge about the principles and main problems of GW management. The students will be familiar with the different methods used in GW prospecting. They will learn the pros and contras, applicability limits of them. The course gives a practical summary and evaluation of the field and laboratory tests, surface (geophysical methods, remote sensing) and direct (CPT, drilling, well instruction) methods of GW exploration. The students will get the fundamentals to be able to plan a complex GW prospecting project, and the protection of GW resources.
The short curriculum of the subject:
Basics of GW management. Types and determination of GW resources. Theory of GW protection. Practical aspects of GW protection, determination of well-head protection areas. Methodology and principles of groundwater prospecting. Geological, geotechnical, geophysical and remote sensing methods used in prospecting groundwater resources. Practical work: self-made solutions of simple case-study problems.
Compatencies to evolve:
Knowledge:
T1 – It includes knowledge of hydrogeology, water resource management, water quality protection, water treatment, production and waterworks operat
T2 – Extensive knowledge of hydrogeological assessment and monitoring techniques related to watershed approach and considers ecological water demands.
T4 – Have a working knowledge of computer-aided design and analysis
T7 – Have knowledge of a wide range of problem-solving techniques for research or academic work.
T8 – Have general and specialist management skills to manage complex design work.
Ability:
K1 – Ability to understand the laws and relationships related to the location, movement and quality of groundwater, to apply and put into practice the knowledge acquired, and to use problem-solving techniques.
K2 – Ability to process information from the knowledge frontiers of professional experience of the discipline, ability of problemsolving, and interpreting hydrogeological issues.
K3 – Ability to independently plan and execute tasks related to groundwater exploration, exploitation and well hydraulics at a high professional level.
K6 – Prepared to tackle complex water resource management, water conservation and aquifer protection challenges.
K10 – Prepared to effectively apply relevant national and European professional, environmental and conservation legislation
K11 – Ability to implement an ecological approach in line with the EU Water Framework Directive
K12 – Ability to work in compliance with EU legislation, to cooperate with foreign partners to solve the tasks required by the EU Water Framework Directive
K13 – The ability to independently participate in and manage research, development and expertise in the field of hydrogeology
K14 – Ability to lead and participate in complex design work and project management in water management and water supply
K15 – Ability to solve complex problems in a flexible way through creative problem solving, to work in a team, to think and cooperate effectively with representatives of other disciplines (e.g. environment, quality, consumer protection, human health, construction, etc.)
Attitude:
A1 – Open-minded and receptive, active in learning about professional and technological methodological developments in the fields of geosciences and environmental engineering, and in solving geological problems from an engineering perspective
A2 – Open and sensitive to problems and sustainability issues related to the environment and its elements
A3 – Have the motivation to work in a changing work, geographical and cultural contexts
A4 – Deep commitment and professional solidarity
A5 – It is committed to lifelong learning, diversity and values
A6 – Respect and act in accordance with the ethical principles and written rules of work and

professional culture, and be able to adhere to them when managing small teams
A8 – Characterised by intuition, consistency and a willingness to learn.
A9 – In addition to his technical and engineering background, he also has an interest in science.
Autonomy and responsibility:
F1 – Act independently and proactively to solve professional problems.
F2 – Have a responsible attitude towards the environment.
F3 – Takes decisions independently and in consultation with other disciplines (mainly legal, economic, energy and environmental), for which it takes responsibility.
F4 – In decisions, takes into account the principles and application of environmental protection, quality, consumer protection, product liability, equal access, health and safety at work, technical, economic and legal regulation and engineering ethics.
F5 – Committed to sustainable natural resource management practices.
F6 – He/she is responsible claims in expert oppinions, professional judgements and for the work carried out under his/her supervision.

Assessment and grading:

Students will be assessed with using the following elements.
During the semester for the signature:

Attendance:	25 %
Practical work	75 %

Final exam grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

Compulsory or recommended literature resources:

- Fetter, C.W. (1988): Applied Hydrology, Merill, Carmel, California
- Freeze, R.A. – Cherry, J.A. (1979): Groundwater, Prentice-Hall, Englewood Cliffs
- Nielsen D.M. (2005): Practical handbook of environmental site characterization and groundwater monitoring, CRC Press, ISBN 9781566705899
- Moore, J.E. (2017): Field hydrogeology, CRC Press
- Keys W. S. (1996): A practical guide to borehole geophysics in environmental investigations, CRC Press

2. TANTÁRGYTEMATIKA

Groundwater prospecting and management
Tantárgytematika (ÜTEMTERV)
Aktuális tanév tavaszi félév
Hidrogeológus mérnök mesterszak MSc, 2. félév, törzsanyagos tárgy

Date	Lectures
2024.02.13.	Summary of basic hydrogeology, physical properties of groundwater, soil and aquifers
2024.02.20.	Principles of GW flow, gw recharge, regional groundwater flow
2024.02.27.	Groundwater and the hydrologic cycle – soil moisture, groundwater recharge and groundwater balance, static and dynamic water resources
2024.03.05.	Surface water resources, groundwater-surface water interaction
2024.03.12.	Shallow and deep porous, karstic-fractured, bank-filtered groundwater resources
2024.03.19.	Groundwater development and management. Global issues and problems of water management. Basics of Groundwater protection.
2024.03.26.	Methodology of Groundwater exploration.
2024.04.02.	official break
2024.04.09.	Surface Geophysical methods
2024.04.16.	official break
2024.04.23.	Subsurface investigations
2024.04.30.	Borehole/Well logging
2024.05.07.	The tools of hydrogeological investigation
2024.05.14.	Remote sensing

Hét	Gyakorlat
2024.02.13.	Basic calculations related to physical properties
2024.02.20.	Interpretation of potential and flow fields using IGW-interactive GW model
2024.02.27.	Calculations of flow gradient, flow velocity, hydraulic head, aquifer pressure
2024.03.05.	Calculations related to water budget
2024.03.12.	Surfer application1: Mapping the elements of the hydrologic cycle

2024.03.19.	Surfer application2: calculation of static groundwater resource
2024.03.26.	Creating and interpretation of pressure-depth function
2024.04.02.	official break
2024.04.09.	Surfer application3: creating potentical maps using different interpolation methods
2024.04.16.	official break
2024.04.23.	Evaluation of pumping tests data
2024.04.30.	Surfer application 4: Visualization of contaminated area, delineation and calculation of contamination
2024.05.07.	Interpretation of spinner flow meter data
2024.05.14.	Excercise in Remote sensing

3) MINTA ZÁRTHELYI

4) ÍRÁSBELI VIZSGA KÉRDÉSSOR

Groundwater prospecting and management
questions for final written test

- Confined and unconfined aquifer (draw)
- Aquifer and aquitard
- The main aquifer materials (geological formations)
- Porous, karstic and fractured aquifers
- Total and effective porosity, primary and secondary porosity
- specific retention
- Darcy's law
- Specific yield
- Specific storage
- permeability, transmissivity
- compressibility, stress's types, effective stress, normal stress, stress changes during pumping
- Hydraulic gradient of the groundwater flow
- Hydraulic head (total head, or potentiometric head), and pressure head
- Potential energy
- Hydraulic pressure
- Artesian well
- Local to regional groundwater flow system
- Recharge and discharge areas
- P-z graph (draw)
- Precipitation, transpiration, evaporation, humidity, dew point, surface runoff, infiltration, recharge, soil storage
- The elements of the hydrologic cycle of Earth
- Capillarity
- Inputs and outputs of the groundwater balance
- Static yield, dynamic yield, exchange rate
- type of groundwater resources, recharge, discharge
- Water sources of confined aquifer during pumping
- Water sources of unconfined aquifer during pumping
- water resource management balance
- ecological water demand, guaranteed flow
- water management, suistanable yield concept
- types of water utilization
- The phenomena of dryland salinity
- Sustainability in water management
- Main problems in groundwater management (only a list)
- The reason of increasing surface runoff and its impacts
- The reason of increasing flood events
- Aquifer depletion and its consequences
- The phenomena of saline intrusion into fresh aquifers (draw)
- Point pollution sources (list)
- Diffuse pollution sources (list)

- What main issues affect the planning of groundwater protection
- Two basic idea of groundwater protection
- The planning principles of qualitative protection of a bank filtered aquifer
- The idea of protection zones based on travel times
- Vulnerable groundwater resource
- The meaning of passive surface geophysical method
- The meaning of active surface geophysical method
- Definition of apparent resistivity
- What factor decrease the measured resistivity?
- The basic of DC resisitivity method
- The basic of Magnetotelluric method
- The basic of Induced polarization method
- The basic of self potential method
- Current and potential field in homogenous system (draw)
- The difference between Wenner and Schlumberger electrode configuration (draw)
- the difference between lateral and sounding surface resistivity survey
- Disadvantages of surface resistivity method
- Sources of Induced Polarization effects underground (list)
- Skin depth
- Basic idea of ground penetrating radar
- Basic idea of seismic refraction method
- Basic idea of gravimetry method
- Logging units (what tools needed for borehole logging)
- Types of logs (list)
- Resisitivity zones around a borehole (draw)
- The basics of natural gamma, gamma-gamma and neutron logging
- The porosity logs
- The basic idea of caliper logging
- The goal of subsurface exploration
- Advantages of machine drilling
- The method of wash boring
- Left and right type of washing
- Geologic logging during drilling
- Hand completed wells
- What is the well screening
- The main well types
- The goal of pumping test
- Type of pumping tests
- Result of a recovery test (graph)
- Result of a step drawdown test (graph)
- Specific capacity of a well in confined aquifer (graph)
- Specific capacity of a well in unconfined aquifer (graph)
- Important features of a pump (list)
- Advantages and limitations of remote sensing
- Possible platforms in remote sensing (list)
- Influencing factors of reflection of EM waves on the earth surface
- The steps of satellite image processing
- Application of remote sensing in hydrogeology

5) ÍRÁSBELI VIZSGA TÉTELSOR

Groundwater prospecting and management questions for final oral exam

1. Elements of the hydrologic cycle, the recharge (evapotranspiration, precipitation, surface runoff, infiltration process, recharge, seasonal and other impacts for shallow groundwater)

2. Aquifer properties (hydraulic conductivity, transmissivity, specific yield and storage, porosity, determination of hydraulic conductivity)

3. Basics of GW flow (hydraulic gradient, Darcy's flow velocity, potential energy, pressure head, total head, hydrostatic pressure, pressure-depth relationship)

4. Theory of hydrogeological unit basin (Tóth J.) (flow and equipotential lines, recharge- and discharge area, scale of groundwater systems)

5. Sustainable yield concept in GW management (static and dynamic yield in case of surface - and groundwater, exchange rate, types of water uses, GW dependent ecosystems, Surface water-gw interaction)

6. Storage and specific yield, GW abstraction from unconfined and confined aquifers, water budget

7. The problems in GW resource management (changes in recharge, aquifer depletion, the origins of groundwater salinization, land subsidence, pollution)

8. Groundwater protection (basic ideas of protection, problems in protection, protection zones, known watersheds, travel times etc)

9. Application of surface geophysical methods (resistivity methods, DC, IP, GPR, MT, seismic m., gravity m., advantages, disadvantages, which method for which type of exploration, needed tools, the results)

10. Application of borehole logging in GW exploration (methods in borehole, resistivity logs radiation logs, penetration depths, interpretation, aquifer identification)

11. Application of well logging (which type of methods can be used in a cased well, which information is given, flow meter, cement bond logs, interpretation of results)

12. Subsurface exploration (types of drilling, investigation methods, well construction, well types, well testing)

13. Remote sensing in GW exploration

14. Tracers and tracer experiments in GW exploration